Cultural Resource

# Across the Desert Floor

## Cultural Resource Investigations Along US 54, Otero County, New Mexico

*Volume II*
*Analysis*

New Mexico State Highway and Transportation Department

**Technical Series 2002-1**

TRC

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Taschek Environmental Consulting

# ACROSS THE DESERT FLOOR
# CULTURAL RESOURCE INVESTIGATIONS ALONG US 54
# OTERO COUNTY, NEW MEXICO
# Volume II

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**Taschek Environmental Consulting**

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Chapter 20

# *From Clay To Pots: Synthesis Of The Ceramic Assemblage*

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## Introduction

Ceramics from the US 54 project include a range of types dating from the Mesilla, Doña Ana, and El Paso phases. Although the majority of ceramics from the project were recovered from LA 6829, representing the late Doña Ana and early El Paso phases, smaller assemblages representing earlier phases were segregated based on ceramic types, El Paso Brown rim morphology, and absolute chronometric dates. Utilizing data presented in the site chapters, along with additional rim and sourcing data, this chapter focuses on synthesis of the ceramic data and exploration of broad research issues.

As outlined in the research design (see Chapter 3; Acklen *et al.* 1999), chronology, resource variability, subsistence adaptations, settlement and demographic patterns, and regional interaction are the primary research domains for the project. From a ceramic perspective, the following chapter addresses issues of chronology, resource selection, subsistence, and regional interaction. The distribution of ceramic types and correlation with absolute chronometric dates are discussed to address issues of chronology and implications for ceramic cross dating. The next section utilizes the microscopic temper classification, oxidation data, petrographic analysis, and NAA results to examine patterns of local pottery production and origins of selected nonlocal ceramics. Vessel form and rim radius data are employed to examine broad trends in vessel morphology and function for the sites and for a larger regional context. Because the assemblage yielded a large number of worked sherds and unique ceramic scrapers, a section of this chapter is devoted to utilizing sherd fragments as tools. Finally, regional interaction is addressed by examining the distribution of all nonlocal ceramics and their origins of manufacture.

## Ceramic Chronology

Since Lehmer (1948) defined the Jornada culture and established the first ceramic typology for the region, issues of ceramic chronology have been at the forefront of research. Because of the ubiquity of El Paso Brownware in Jornada assemblages, researchers have sought to define a chronologically sensitive method for classifying El Paso Brown, El Paso Bichrome, and El Paso Polychrome ceramics (e.g., Carmichael 1983, 1985; Lehmer 1948; Whalen 1977, 1978, 1980, 1993, 1996). Based on Lehmer's (1948) observation that differences in the morphology of El Paso were temporally sensitive, Whalen (1978) proposed a developmental sequence of rim and neck forms for El Paso Brown and El Paso Polychrome. To quantify differences in rim forms, West (n.d.), developed a "rim sherd index" (RSI) to measure changes in rim morphology. The calculation consists of taking two measurements of wall thickness at 2 mm and 15 mm below the rim and using the 2 mm measurement as the numerator and the 15 mm measurement as the denominator to compute a single measure. For a large assemblage or multiple assemblages, this measure may be used to temporally distinguish El Paso Brownware ceramic components. Segregating RSI measurements for brownware types and vessel forms, Carmichael (1983, 1985) and Seaman and Mills (1985) demonstrate the application of the method for distinguishing Mesilla, Doña Ana, and El Paso phase brownware. RSI is especially useful for distinguishing Mesilla phase assemblages for which other relative or absolute chronometric data are lacking. As indicated by Seaman and Mills (1985), the need for absolute chronometric data is critical for continual refinement of this relative dating tool.



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For the US 54 ceramics, 248 El Paso Brownware rims, from six sites, were large enough to obtain RSI measurements. Figure 20.1 shows the mean RSI for all six sites, as a group, divided by ceramic type and vessel form. The graph shows considerable differences from jars to bowls, supporting the idea that controlling for vessel form is important in using the RSI. Jars predominate in the sample, thus, the trends through time for jars only, and for all vessel forms, are very similar. Bowls seem to reflect other factors, and do not show a progression through time from El Paso Brown, to El Paso Bichrome, to El Paso Polychrome. The RSI values for El Paso Brown bowls are higher than those for the other two types. This finding probably reflects the functional differences between bowls and jars. Because sites from several time periods are combined in the overall US 54 assemblage, we cannot assess the chronological importance of the RSI for these sites. To do so, examination of each site must be undertaken. As an aside, because of the considerable differences between the RSI values for bowls and jars and the predominance of jar data in the assemblage, the discussion here will focus on jar forms.

Table 20.1 shows the RSI values for each site along US 54. Turning first to the sites with limited assemblages, LA 128699 has an RSI value for only one type (El Paso Brown) and only one vessel form category: jars. The value for this site is 0.642, quite low, and suggests a Mesilla phase date. This is consistent with chronometric dates from the site, which include several radiocarbon determinations that fall within the Mesilla phase (see Chapter 14).

LA 126181 has a single RSI value for El Paso Polychrome jars of 1.170. The lack of El Paso Brown makes these data hard to interpret. The RSI value for El Paso Polychrome is quite comparable to that obtained for other sites. It is most similar to LA 115265, which also produced an RSI on El Paso Brown of 0.795. This value might suggest an earlier date, because lower index values generally correlate with earlier sites. Three of four radiocarbon dates from LA 126181 fall within the Mesilla phase, with the fourth correlating primarily with the Doña Ana phase. The ceramic assemblage, however, indicates a primarily Doña Ana phase component at the site.

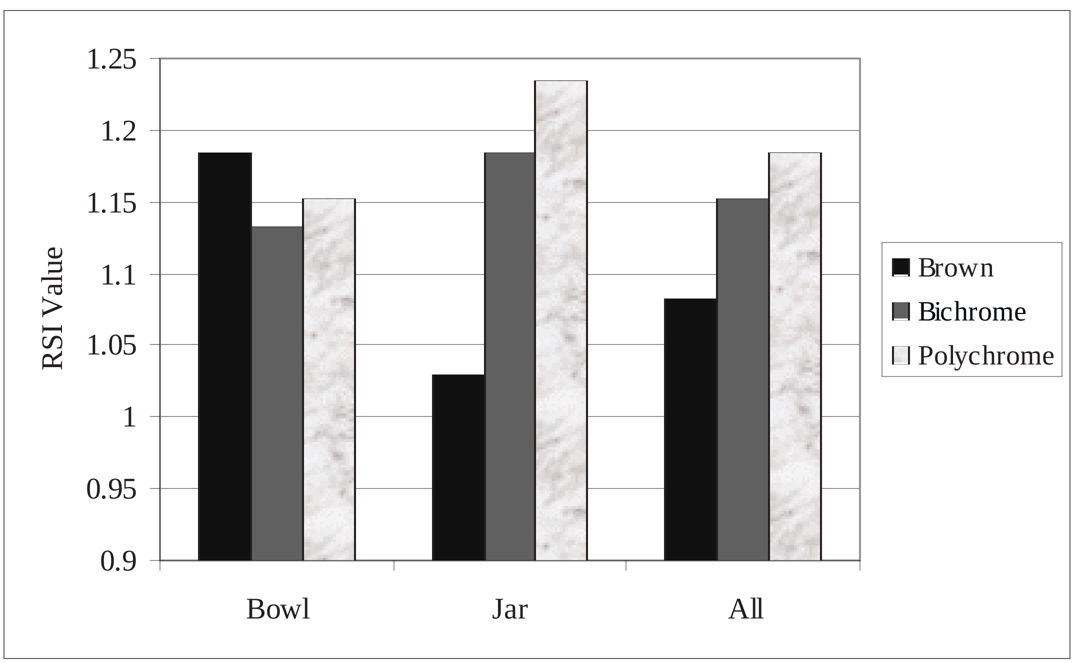


**Figure 20.1 RSI values for El Paso Brownware types from the project sites.**



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**Table 20.1 Rim Sherd Index Values for US 54 Sites**

| Ceramic Type | Vessel Form | LA 6829 | LA 128699 | LA 115260 | LA 115265 | LA 126181 | LA 128700 | All Sites |
|---|---|---|---|---|---|---|---|---|
| El Paso Bichrome | Bowl | 1.131 | 0 | 1.186 | 0 | 0 | 0 | 1.133 |
| | Jar | 1.155 | 0 | 1.259 | 0 | 0 | 1.125 | 1.184 |
| El Paso Brown | Bowl | 1.202 | 0 | 1.089 | 0 | 0 | 1 | 1.185 |
| | Jar | 1.067 | 0.642 | 1.045 | 0.795 | 0 | 1.111 | 1.029 |
| El Paso Polychrome | Bowl | 1.164 | 0 | 1.052 | 0 | 0 | 0 | 1.153 |
| | Jar | 1.287 | 0 | 1.087 | 1.169 | 1.17 | 1.026 | 1.234 |

The Jaca site (LA 6829) produced RSI values for all three ceramic types, and for both bowl and jar forms. Figure 20.2 shows the RSI data for the site. Data from the site show a progression in RSI values among jars from El Paso Brown, to Bichrome, to Polychrome. The RSI mean for El Paso Brown jars (1.067) is high enough to suggest an El Paso Phase date for the site. Prior work by Seaman and Mills (1985) and Carmichael (1983) produced RSI values for El Paso Brown below 1 for both Mesilla and Dona Ana phase sites. Only El Paso phase sites produced values over 1. For the Jaca site, the values for El Paso Bichrome (1.155) and Polychrome (1.287) are sufficiently high as to indicate an El Paso phase date (again, compared to prior work). Chronometric data from LA 6829 confirm a substantial late Doña Ana to early El Paso phase occupation.

LA 115260 also produced RSI values for all types and vessel forms. Figure 20.3 shows the results of the RSI analysis. The values for El Paso Brown and Bichrome are similar to what we have seen for other sites, but the El Paso Polychrome means are surprisingly low. This may reflect small sample size, or just an odd assemblage for the type at this particular site. The El Paso Brown RSI mean of 1.045 supports a late date for the assemblage, probably El Paso phase, as does the value for El Paso Bichrome. Radiocarbon dates from this site, however, fall primarily within the late Mesilla and early Doña Ana phases (see Chapter 9).

For LA 115265, RSI values were calculated for jars of El Paso Brown and Polychrome. The value for El Paso Brown is very low (0.795) and if the site lacked polychrome, we would not hesitate to assign it to the Mesilla Phase. The value for El Paso Polychrome is 1.169, not particularly high. Despite the lack of El Paso Bichrome, together, these values might suggest an intermediate Doña Ana phase occupation for the site; a radiocarbon date from a single feature supports a Doña Ana phase designation.

Finally, we come to LA 128700, which produced some unusual RSI values (Figure 20.4). El Paso Brown ceramics from the site had a mean RSI of 1.111, which suggests a late date, as supported by the rest of the assemblage. The values for El Paso Bichrome (1.125) and Polychrome (1.026) are quite similar and do not show the differences that we have seen at other US 54 sites, and in prior work in the region. Radiocarbon dates from the site correlate primarily with the Doña Ana phase, suggesting that the high RSI value for the El Paso Brown ceramics may be anomalous or a result of small sample size.

Overall, the RSI analysis did not produce results that matched absolute chronometric dates. It is unclear why the RSI values for El Paso Brown from the US 54 project did not match previous studies showing a clear transition from early to late forms. Regardless of the temporal placement of the El Paso Brown ceramics, the RSI values were fairly homogenous suggesting an overall tighter temporal range for the project sites as opposed to those involved in previous studies (see Seaman and Mills 1985). Given the probable late Doña Ana to early El Paso phase occupation at



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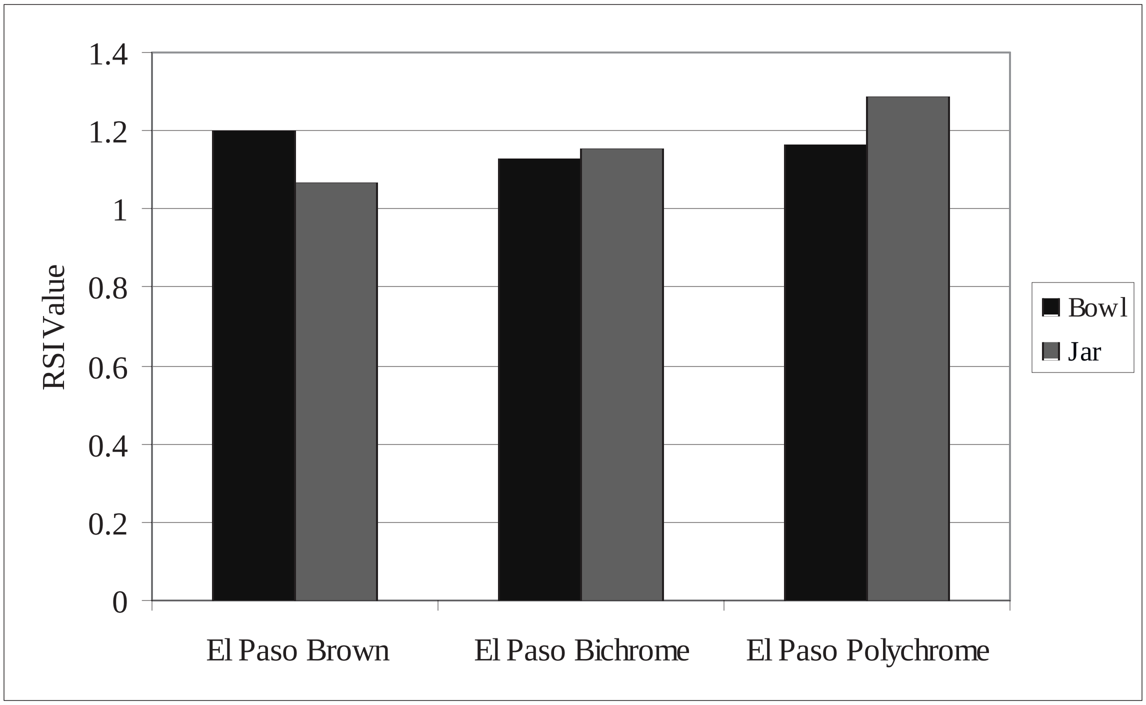


**Figure 20.2 RSI values for El Paso Brownware rims from LA 6829.**

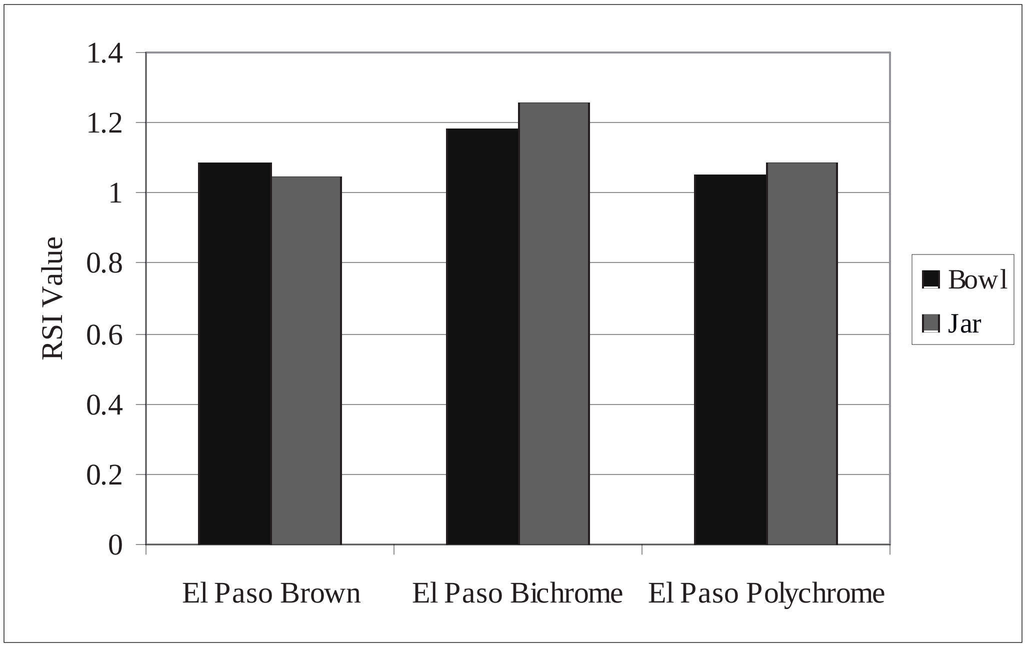


**Figure 20.3 RSI values for El Paso Brownware rims from LA 115260.**

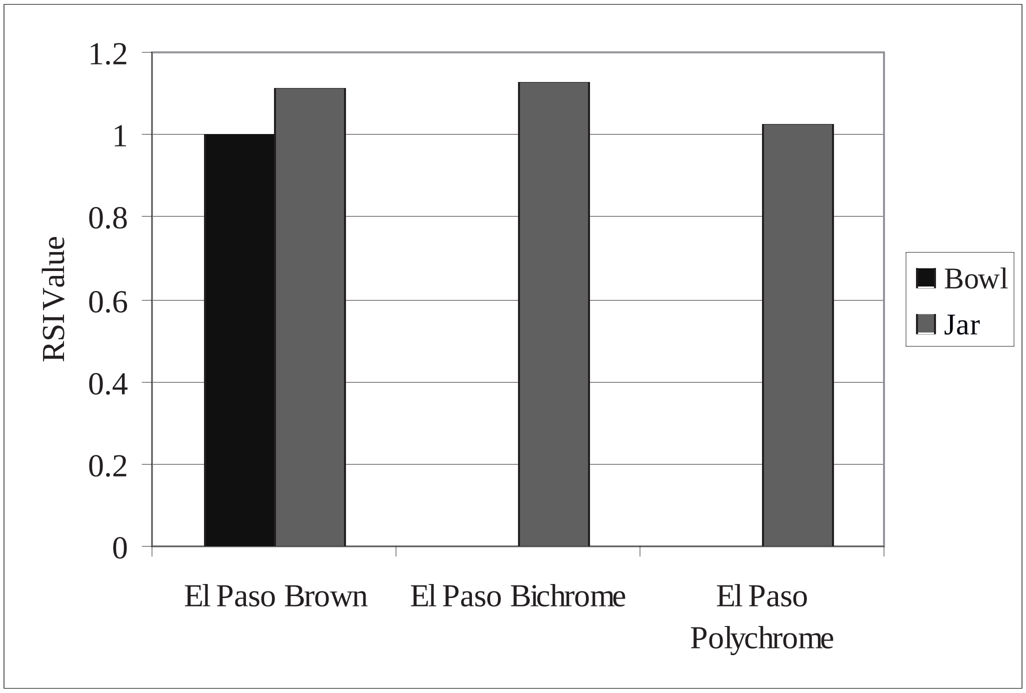


**Figure 20.4 RSI values for El Paso Brownware rims from LA 128700.**

LA 6829, the smaller, late sites close to this large village (i.e., LA 115260, LA 115265, LA 126181, and LA 128700) may similarly date from the Doña Ana/El Paso transition, explaining the homogeneity in the RSI and the clustering of RSI values above one. The RSI data, ceramic cross-dating, and radiocarbon dates for the assemblages are discussed in further detail below by temporal phase. In most cases, the ceramic type data and radiocarbon dates from the sites correlate well, providing good chronometric control for most of the temporal components. In the following sections, each of the temporal periods is briefly discussed and additional chronometric data are presented. More detailed description and interpretation of site components are presented in the relevant site chapters.

## *Mesilla Phase Assemblages*

Based on ceramic data and radiocarbon dates, five sites have probable Mesilla phase components. These include LA 115256, LA 115259, LA 115262, LA 128699, and LA 128708. LA 126181 produced Mesilla-phase radiocarbon dates, but this phase is not clearly represented in the site's ceramic assemblage. The ceramic assemblages from these sites include predominantly El Paso Brown with only one site (LA 115262) having Alma Plain tradeware from the Mimbres region. As shown in Table 20.2, ceramic dates for these two types span a long time period, but radiocarbon dates support Mesilla phase associations dating between roughly A.D. 200 and 1100.

RSI values calculated for LA 128699 support a Mesilla phase designation for the ceramic assemblage. The remaining sites listed in Table 20.2 either yielded no rim sherds or had rim sherds too small to calculate RSI values.

## *Doña Ana Phase Assemblages*

Five site components were identified as dating to the Doña Ana phase, including Jaca (LA 6829), LA 115260, LA 115265, LA 126181, and LA 128700. As shown in Table 20.3, features from all of the sites yielded radiocarbon dates falling within the time range for the Doña Ana phase, A.D. 1100–1250 (Hard *et al.* 1994). Ceramic

**Table 20.2 Chronometric Data for Mesilla Phase Assemblages**

| Site Number | Ceramic Types | Ceramic Dates | Radiocarbon Dates |
|---|---|---|---|
| LA 115256 | El Paso Brown | A.D. 200–1200 | A.D. 330–580 (Feature 3) |
| LA 115259 | El Paso Brown | A.D. 200–1200 | A.D. 350–440 (Feature 7) |
| LA 115262 | El Paso Brown | A.D. 200–1200 | A.D. 230–550 (Feature 1.01) |
| | Alma Plain | A.D. 200–900 | |
| LA 128699 | El Paso Brown | A.D. 200–1200 | A.D. 330–1290 * |
| LA 128708 | El Paso Brown | A.D. 200–1200 | A.D. 570–900* |

* Range of multiple radiocarbon dates, based on two-sigma calibrations

**Table 20.3 Chronometric Data for Doña Ana Phase Assemblages**

| Site Number | Ceramic Types | Ceramic Dates | Radiocarbon Dates |
|---|---|---|---|
| LA 115260 | El Paso Brown | A.D. 200–1200 | A.D. 970–1170* Feature 1 |
| | El Paso Bichrome | A.D. 1100–1150 | |
| | El Paso Polychrome | A.D. 1100–1450 | |
| | Jornada Brown | A.D. 200–1250 | |
| LA 115265 | El Paso Brown | A.D. 200–1200 | A.D. 870–1220 Feature 1 |
| | El Paso Bichrome | A.D. 1100–1150 | |
| | El Paso Polychrome | A.D. 1100–1450 | |
| | San Andres Plain | A.D. 1000–1200 | |
| LA 126181 | El Paso Brown | A.D. 200–1200 | A.D. 1050–1290* Feature 24 |
| | El Paso Bichrome | A.D. 1100–1150 | |
| | El Paso Polychrome | A.D. 1100–1450 | |
| | Chupadero B/W | A.D. 1150–1400 | |
| LA 128700 | El Paso Brown | A.D. 200–1200 | A.D. 1060–1280* Feature 33 |
| | El Paso Bichrome | A.D. 1100–1150 | |
| | El Paso Polychrome | A.D. 1100–1450 | |
| | Chupadero B/w | A.D. 1150–1400 | |
| LA 6829 | El Paso Brown | A.D. 200–1200 | A.D. 900–1260 Structure 6 ; A.D.1050–1290 Structure 15 ; A.D. 1160–1300 Structure 17 |
| | El Paso Bichrome | A.D. 1100–1150 | |
| | El Paso Polychrome | A.D. 1100–1450 | |
| | Chupadero B/w | A.D. 1150–1400 | |

* Range of multiple radiocarbon dates, based on two-sigma calibrations.

types associated with the Doña Ana components include El Paso Brown, El Paso Bichrome, El Paso Polychrome, Jornada Brown, San Andres Plain, and Chupadero Black-on-white. Although not listed in Table 20.3, indeterminate Mimbres Black-on-white, generally associated with late Mesilla and Doña Ana phase components in the region, was identified in undated contexts from LA 6829. Stratigraphic and radiocarbon data from LA 6829 suggest a late Doña Ana to early El Paso-phase presence. Structures 2, 4, 6, 11, 13, and 15–17 at LA 6829 have radiocarbon dates, stratigraphic evidence, and/or ceramic assemblages indicating probable Doña Ana-phase affiliation. Although ceramic designation of Doña Ana phase for most of the US 54 components was based primarily on the lack of later tradeware types characteristic of the El Paso phase, radiocarbon dates from features at all of the sites support the ceramic data. RSI values for the Doña Ana phase components are not as clear as the Mesilla phase values, but do indicate rim thickness changes through time.

### *El Paso Phase Assemblages*

LA 6829 is the only El Paso phase ceramic component identified within the project area. This site is a large village dating to the late Doña Ana and early El Paso phase based on ceramic and radiocarbon data. As discussed in greater detail in the site chapter, eight of the 16 structures with ceramics probably date to the early El Paso phase or transitional late Doña Ana/early El Paso time frame. Calibrated radiocarbon dates with time spans ranging up to A.D. 1420 support an El Paso-phase presence at this site. As shown in Table 20.4, many of the diagnostic types overlap both the Doña Ana and El Paso phases, and radiocarbon dates from the site are compatible with a late



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**Table 20.4 Temporally Diagnostic Ceramic Types from the El Paso Phase Component at LA 6829**

| Ceramic Types | Ceramic Dates |
|---|---|
| El Paso Polychrome | A.D. 1100–1450 |
| Chupadero B/w | A.D. 1150–1400 |
| Three Rivers Red-on-terracotta | A.D. 1150–1350 |
| Playas Red Incised | A.D. 1060–1340 |
| Corona Corrugated | A.D. 1225–1460 |
| St. Johns Black-on-red | A.D. 1175–1300 |

Doña Ana/early El Paso phase occupation. RSI values for El Paso Brownware rims are variable, but for the most part also support an El Paso phase component. Because El Paso Polychrome sherds from the site were fragmentary and reconstructible vessels were not recovered, evaluation of design styles within a temporal context could not be undertaken. O'Laughlin (2001a) and Myles Miller (personal communication, October 2000) have both examined the temporal implications of El Paso Polychrome design changes. Most of the diagnostic aspects of design layout are best examined with partial or whole vessels, which were not present at LA 6829. Finally, the predominance of El Paso Polychrome in the assemblage and the paucity of El Paso Brown rim sherds is another indication that the primary occupation dates from the late Doña Ana and early El Paso phases. By the beginning of the El Paso phase, painting of brownware utility pots was the primary surface treatment for all vessel categories replacing the predominantly plain brownware vessels of the earlier phases.

## Clay and Temper Studies

Over the last decade, ceramic studies have expanded beyond standard macroscopic temper identification as the primary means of determining production origins. Although temper is a useful attribute for assigning local versus nonlocal pottery, the greater amount of detail afforded with petrographic and geochemical analyses has greatly expanded the research potential of ceramic artifacts. Many researchers in the Jornada region have previously employed either petrography or Neutron Activation Analysis (NAA) as the primary technique for ceramic sourcing studies. Both of these techniques used alone are an excellent means of supplementing a standard ceramic analysis and addressing research questions concerning ceramic production and distribution. Taken together, and in conjunction with other geochemical assessments, their potential is heightened. A multi-analytical approach of this kind (using, for example, oxidation, petrographic and NAA analyses) offers complementary data sets strengthening interpretations based on any single analytical technique (e.g., Rands and Weimer 1992). Also, when combined with raw clay and temper collections, questions concerning ceramic production and source may be tuned to a very fine scale.

For the US 54 collections, oxidation, petrography, and NAA were employed to further explore clay and temper variation among various ceramic types. This analysis was geared towards several objectives. First, specific sources were sought for intrusive ceramics, with the goal of gaining a better understanding of the diversity of the intrusive ceramic assemblage (i.e., whether individual types derive from single or multiple sources). Second, a greater understanding of local ceramic production was sought. In conjunction with the latter objective, a limited clay and temper survey was undertaken within and around the project area. Clay collections were limited because proximity of the Fort Bliss Military Range created access problems, and curtailed adequate sample collection. The geology in the immediate vicinity of the US 54 sites yielded no clay samples. Areas holding the greatest potential for clay deposits and tempering materials were beyond the project area on Fort Bliss property. A brief reconnaissance of the Jarilla Mountain area to the north also yielded no clay deposits. Rock fragments collected from the Jarilla Mountains also lack the alkali-feldspar granite identified in the sherd samples from the project.

Results of the oxidation, petrographic, and NAA analyses are discussed below.



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### *Oxidation Analysis*

For an initial evaluation of clay resource selection, 557 sherd samples from seven sites (Table 20.5) were refired in an oxidizing atmosphere. Oxidation (refire) analysis is a simple method for classifying ceramic pastes based on oxidized color (Rice 1987; Shepard 1980). As discussed by Shepard (1980:104), firing clay or refiring sherds in an oxidizing atmosphere brings out the clearest colors. Although other mineral constituents of clay occasionally affect fired color, the form and amount of iron oxide is the primary influence on color. Thus, in an oxidizing atmosphere at temperatures less than about 1000° C, the iron content of clay greatly influences the resulting color. At this temperature and above, ferric oxide begins to lose oxygen (even in an oxidizing atmosphere) and cannot exist at temperatures greater than 1300° C (Shepard 1980:23). Because primitive firing techniques, such as those used by the Mogollon, rarely attain temperatures above 1000° C, iron oxides are a principle factor in determining color of the fired clay. Although this explanation is simplistic, it is important to realize that clay is "one of the most complex and variable materials that nature affords" (Shepard 1980:24). Mineral constituents of clays are highly variable between sources and even within single sources, thus variability in the mineralogy may be sufficient to produce slight inconsistency in fired colors. Reliance on oxidation analysis is predicated on the low firing temperatures of most prehistoric pottery and the influence of iron oxides on fired clay color. By firing clay samples and refiring sherd fragments from prehistoric vessels in a consistently oxidizing atmosphere, clays and sherd fragments reach their clearest colors and thus are directly comparable. The resulting colors of sherds and raw clays can then be attributed to general compositional differences or similarities (Bubemyre and Mills 1993:236). In most studies,

**Table 20.5 Sites and Ceramic Types Samples for Oxidation Analysis**

| Ceramic Type | 6829 | 115256 | 115259 | 115260 | 115262 | 115265 | 126181 | Total |
|---|---|---|---|---|---|---|---|---|
| Alma Plain | 2 | | | | 4 | | | 6 |
| Banded gray | 1 | | | | | | | 1 |
| Chupadero Black-on-white | 111 | | | | | | 3 | 114 |
| Corona Corrugated | 5 | | | | | | | 5 |
| El Paso Bichrome | 32 | | | 12 | | 5 | 14 | 63 |
| El Paso Brown | 28 | 3 | 1 | 45 | 10 | 20 | 27 | 134 |
| El Paso Polychrome | 98 | | | 39 | | 1 | 21 | 159 |
| Indet. Mimbres Black-on-white | 1 | | | | | | | 1 |
| Indet. unfired vessel | | | | 1 | | | | 1 |
| Indet. White Mountain b/r | 2 | | | | | | | 2 |
| Indet. White Mountain Red Ware | 2 | | | | | | | 2 |
| Jornada Brown | 2 | | | | 2 | | | 4 |
| Jornada Red | 3 | | | | | | | 3 |
| Plain gray | 3 | | | | | | | 3 |
| Playas Incised (Sierra Blanca Var.) | 5 | | | | | | | 5 |
| Playas Red | 1 | | | | | | | 1 |
| Playas Red Incised | 16 | | | | 1 | | | 17 |
| San Andres Plain | | | | | | 1 | | 1 |
| St. Johns Black-on-red | 2 | | | | | | | 2 |
| Three Rivers Broad-lined Red-on-terracotta | 1 | | | | | | | 1 |
| Three Rivers Red-on-terracotta | 24 | | | | | | | 24 |
| **Total** | **339** | **3** | **1** | **97** | **17** | **27** | **65** | **549** |



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sherds and raw material samples are fired in an electric kiln and held at a temperature of 950° C for 30 minutes (Bubemyre and Mills 1993; Reed *et al.* 1998; Windes 1977).

To obtain greater comparability, oxidized sherd and clay Munsell colors are usually grouped into a smaller number of categories. For the US 54 analysis, standard Munsell colors are grouped into buff, yellowish-red, and red color groups (Windes 1977). Table 20.6 lists the Munsell colors (Munsell 1994) assigned to the oxidized sherds from US 54 and the color group designation assigned to each Munsell color. Basically, color groups provide higher-level categories with which to track and graph general trends in clay selection (see Bubemyre and Mills 1993; Hensler 1999; Reed *et al.* 1998). They also help eliminate idiosyncratic variation in color perception by different analysts. Although oxidation analysis has been used most commonly with Anasazi assemblages, its application to Jornada ceramics was considered useful due to the variety of wares and types identified in these assemblages.

**Table 20.6 Munsell Colors and Color Group Designations for the US 54 Samples**

| Color Group | Munsell Color (1994) |
|---|---|
| Buff (1) | 10YR7/3; 10YR7/4; 10YR7/6; 10YR8/1; 10YR8/2; 10YR8/3; 10YR8/4 |
| | 2.5Y7/3; 2.5Y8/1; 2.5Y8/2; 2.5Y8/3; 2.5Y8/4 |
| | 5Y7/1 |
| Buff (2) | 10YR8/6 |
| | 2.5Y8/3 |
| | 7.5YR8/1; 7.5YR8/2; 7.5YR8/3; 7.5YR8/4 |
| Buff (3) | 10YR6/4 |
| | 2.5Y8/2; 2.5Y8/3 |
| | 2.5YR8/1 |
| | 7.5YR8/6 |
| Yellowish Red (4) | 10YR7/6 |
| | 2.5YR5/8 |
| | 5YR 6/8; 5YR8/4 |
| | 7.5YR6/4; 7.5YR6/8; 7.5YR7/6; 7.5YR7/8; 7.5YR8/2 |
| Yellowish Red (5) | 2.5YR7/8 |
| | 5YR5/6; 5YR5/8; 5YR6/8; 5YR7/8 |
| Red (6) | 2.5YR4/6; 2.5YR4/8; 2.5YR5/6; 2.5YR5/8; 2.5YR6/8 |
| Red (7) | 10R4/8; 10R5/6; 10R5/8; 10R6/8; 10R7/8 |

**Local Ceramic Production Evidence**

The largest refired assemblage is that of the El Paso Brownware. In Figure 20.5 the color distribution of 356 El Paso Brownware, El Paso Polychrome, and El Paso Bichrome sherds is contrasted with seven undifferentiated Jornada Brown and Jornada Red sherds. In all of the identified types, the most common paste color is red (Color Group 6), followed by yellowish-red (Color Group 5). These darker color groups are commonly found in the secondary and alluvial clays typical of the Basin and Range province. A reversal in the prevalence of these same two color groups in the undifferentiated types is likely caused by the comparatively small data set for these types rather than any major differences in clay selection.

The question of whether different clay sources were used for decorated and plain ceramics is difficult to address in the El Paso Brownware series because of gross similarities in pastes. Large design motif size and design layouts that leave large portions of decorated vessels unpainted cause difficulty in consistently sorting decorated from undecorated El Paso Brownware sherds. Similar problems are found in differentiating bichrome from polychrome sherds. For this reason, while it may be stated unequivocally that those sherds typed as El Paso Polychrome in Figure 20.5 are indeed portions of polychrome vessels, those typed as El Paso Bichrome may include some sherds from portions of polychrome vessels, and those typed as El Paso Brown may include undecorated portions of either of the decorated types. A more realistic segregation of the two decorated types and the plainware is obtained when considering rim sherds alone (but see Miller 1990).



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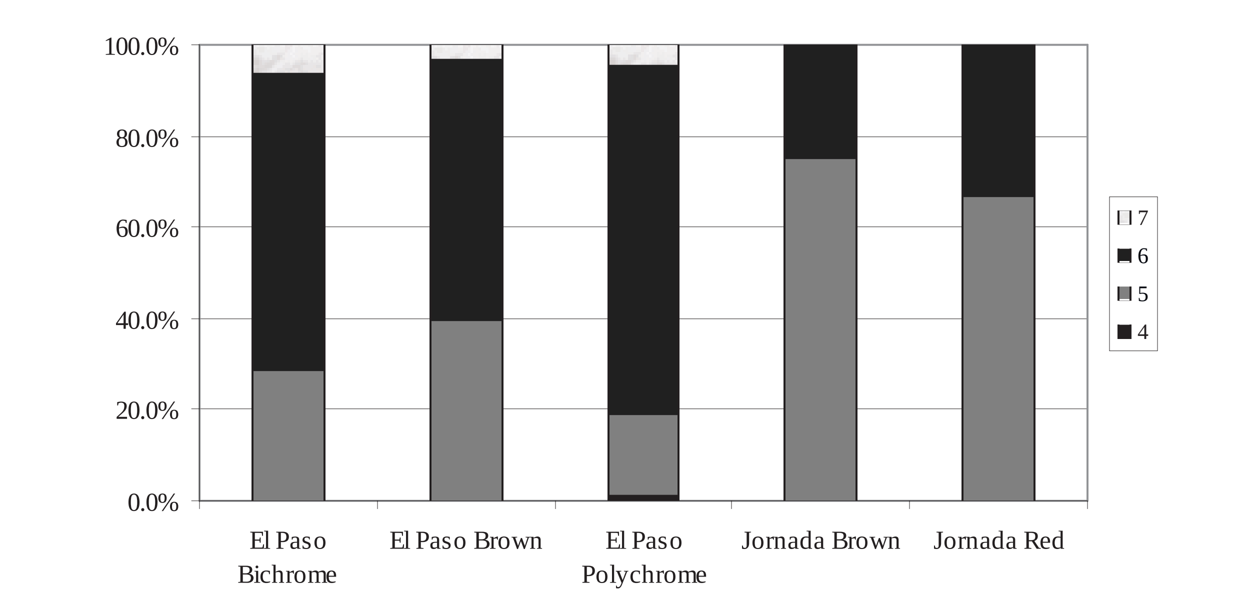


**Figure 20.5 The distribution of refired paste colors by Color Group for Jornada and El Paso Brownware (see Table 20.6 for color category names corresponding to numbers 4–7 in this figure).**

In Figure 20.6, 85 El Paso Bichrome, El Paso Brown, and El Paso Polychrome rim sherds from LA 6829, LA 115260, LA 115265, and LA 126181 are sorted by color group. Again, as in the larger sample reported above, there is greater use of the red firing clays (Color Group 6) in El Paso Polychrome. However the differences in proportions between color groups are not as strongly expressed in this smaller sample. Thus, while different clay sources may have been used for decorated and plain El Paso Brownware, differences suggested by color analysis are suggestive but inconclusive at this time. Given further refired color analyses in the Jornada Region, however, more definitive conclusions may be reached. Of particular interest in this regard are well-dated earlier and later site assemblages.

While insufficient ceramic recovery limited chronological comparison of each El Paso Brownware type through time, a comparison of grouped brownware is possible when each site is considered in turn. In Figure 20.7, the five US 54 El Paso Brownware assemblages with ten or more refired sherds are considered through time. LA 115262 is the single Mesilla phase site considered. LA 6289 is a Doña Ana to El Paso phase site while the remaining sites all fall within the Doña Ana phase.

As seen in Figure 20.7, there are no distinctive temporal trends in clay color selection through time. Instead, there appears to be a great deal of intersite variability, even in sites dating to the same phase (i.e., LA 115260, LA 115265, and LA 126181). Two points are raised. First, intersite variability is often cited as an argument supporting multiple ceramic production locales. Second, it becomes clear when examining the proportions of El Paso Polychrome (see Figures 20.5 and 20.6) that the marginally preferential use of Color Group 6 in this type is likely attributable to the origination of many of these sherds from LA 6829.

In conclusion, no evidence was found in the US 54 assemblage of differential clay use for decorated versus plain El Paso Brownware. A corollary argument could state that the same potters were likely making all three types, El Paso Bichrome,



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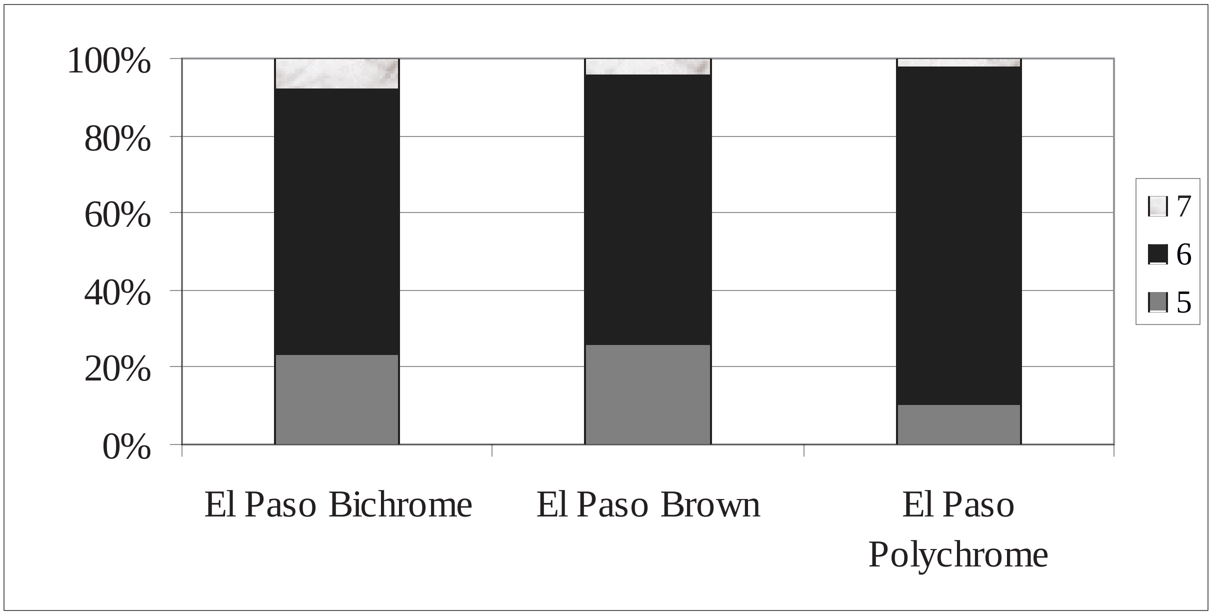


**Figure 20.6** **The distribution of refired color paste by Color Group for El Paso Brownware rims.**

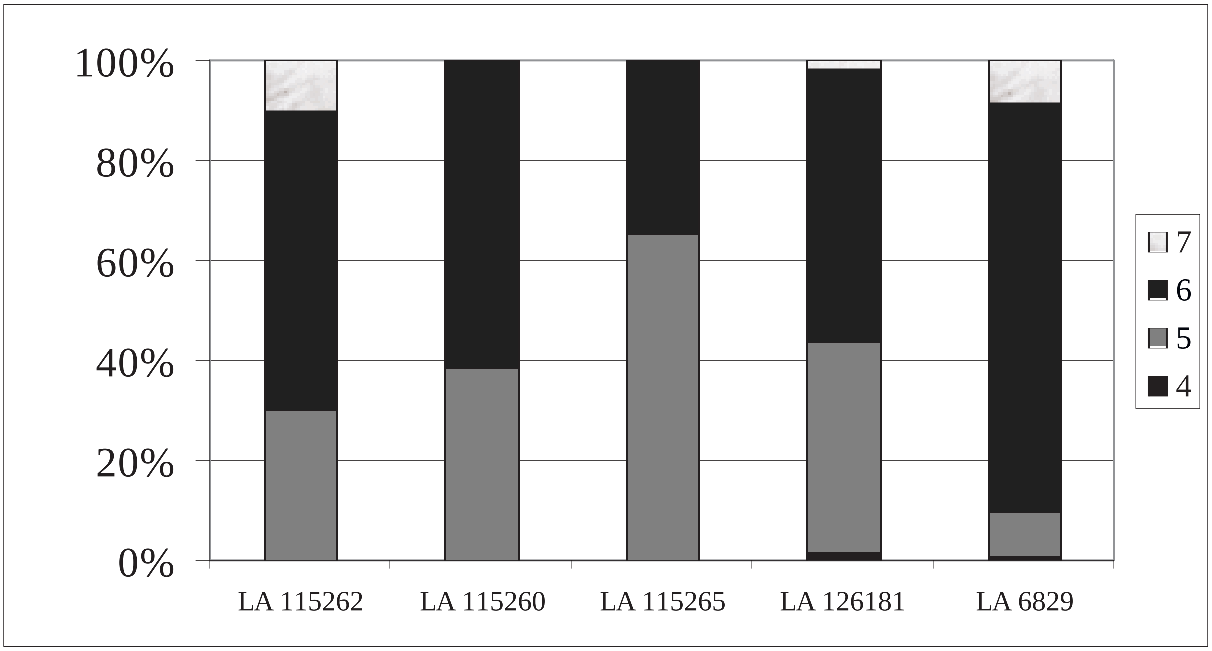


**Figure 20.7** **The distribution of refired paste color by Color Group for El Paso Brownware from five sites.**

El Paso Brown, and El Paso Polychrome. Differences in production locales, however, are suggested when examining intersite color variability. The distinctive proportions of red-firing sherds at LA 6829, taken together with other material evidence for ceramic production (see below) suggest that this site likely produced most of its own El Paso Brownware. Other production sources for these wares are indicated, however, by widely differing color proportions at other US 54 sites.

### Intrusive Ceramic Production Evidence

Chupadero Black-on-white is the most abundant imported ceramic type in the US 54 collections. This is a very long-lived type, especially for a white ware (Oppelt 2002). Thus temporal as well as spatial differences in production locale are of interest. The US 54 Chupadero Black-on-white was sorted by stylistic analog to more tightly dated white ware from central and northern New Mexico and Arizona, as described above. The four stylistic analogs correspond to Dogoszhi Black-on-white, Sosi Black-on-white, Reserve Black-on-white, and Tularosa Black-on-white.

While Chupadero Black-on-white dates between A.D. 1150 and 1550, the analogous types cover a more limited portion of this time span. In Figure 20.8, color group arranges the four styles described for Chupadero Black-on-white in approximate chronological order.

Eighty-five refired Chupadero sherds were assignable to a specific style, but only one sherd was Tularosa style. Thus, the uniformity of color shown in Figure 20.8 for this design style is not representative. Of greater interest are differences in paste color between Sosi and Reserve style sherds, both of which are represented by sizable sample numbers. These two design styles are based on analogous northern ceramic types with very similar chronologies. Thus, the differences in paste colors expressed in Figure 20.8 may represent spatial rather than temporal differences in production sources. Since all of these sherds derive from the same site (LA 6829) however, this is difficult to determine independently. Again future color comparison with other Jornada sites may help to further define this variation.

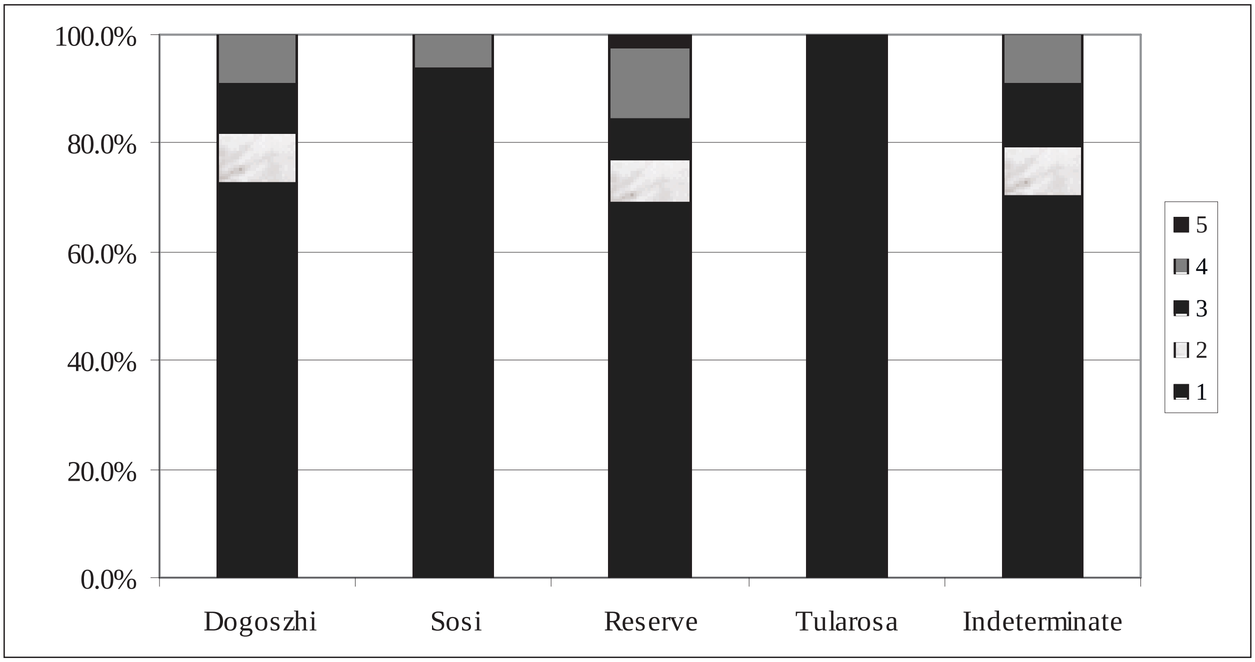


**Figure 20.8 The distribution of refired paste colors by Color Group for Chupadero Black-on-white design styles.**

Color analysis of the remaining intrusive ceramic types is useful primarily for determining minimal numbers of vessels imported to LA 6829, LA 115262, and LA 115265 (Table 20.7).

**Table 20.7 Minimal Number of Imported Vessels for LA 6829, LA 115262, and LA 115262.**

| Ceramic or Generic Type | LA 6829 | LA 115262 | LA 115265 | Total |
|---|---|---|---|---|
| Alma Plain | 1 | 1 | | 2 |
| Banded Gray | 1 | | | 1 |
| Corona Corrugated | 2 | | | 2 |
| Indeterminate Mimbres Black-on-white | 1 | | | 1 |
| Indeterminate White Mountain Red Ware | 1 | | | 1 |
| Plain Gray | 3 | | | 3 |
| Playas Incised (Sierra Blanca Variety) | 2 | | | 2 |
| Playas Red/Playas Red Incised | 3 | 1 | | 4 |
| St. Johns Black-on-red | 2 | | | 2 |
| San Andres Plain | | | 1 | 1 |
| Three Rivers Broad-lined Red-on-terracotta | 1 | | | 1 |
| Three Rivers Red-on-terracotta | 4 | | | 4 |
| Total | 21 | 1 | 1 | 24 |

## ***Petrographic Analysis***

Six sherds from LA 6829 were submitted to Andrea Carpenter for petrographic analysis. Her results are summarized here, while her complete report is found in Appendix A. Of the six sherds, two were Chupadero Black-on-white, two were El Paso Polychrome, one was El Paso Brown, and one was Alma Plain. The Chupadero Black-on-white, El Paso Polychrome, and El Paso Brown sherds are all tempered with crushed sherd and/or alkali-feldspar granite. The alkali-feldspar granite is characterized petrographically as fine to medium grained with potassium feldspar (microperthitic to perthitic microcline) and quartz, and minor plagioclase, granophyric quartz-feldspar intergrowths, sphene, and opaque minerals. Multiple sources (possible cobbles) of alkali-feldspar granite appear to have been used by the prehistoric potters. Ferromagnesian minerals, such as biotite and aegirine, differentiate these alkali-feldspar granite sources.

A granitic intrusion through sedimentary limestone deposits is present in the Jarilla Mountains near Orogrande, New Mexico. However, limited field studies in 2001 for the project showed that this area contains extensive mining material (dirty rocks) and lacks substantial examples of alkali-feldspar granite. The nearby Organ Mountains also lack alkali-feldspar granite and contain primarily quartz monzonite. The most likely source for the alkali-feldspar granite observed in the sherds is the Sierra Blanca Peak area near Ruidoso in the northwestern part of the Mescalero Apache Indian Reservation (Moore *et al.* 1988a) or drainages leading from this locale. Other potential sources for alkali-feldspar granite are the Pajarita Mountain area northeast of Tularosa and the Palomas Gravel that fills the Tularosa Basin (Moore *et al.* 1988b).

Patricia Capone of the Peabody Museum at Harvard University petrographically analyzed Chupadero Black-on-white sherds from the Robinson Pueblo site near Sierra Blanca Peak. The temper reported in these sherds was primarily lithic fragments of syenite, composed of 90 percent potassium feldspar, two percent quartz, one percent hornblende, and one percent biotite (Patricia Capone, personal communication 2002). Unlike the reported Robinson site temper, temper grains in the US 54 sherds are primarily monomineralics of potassium feldspar and quartz, with lesser amounts of lithic, alkali-rich intrusive grains. These intrusive grains contain greater than five percent quartz and are therefore, according to the IUGS classification scheme for igneous rocks, alkali-feldspar granite. The Robinson Pueblo sherds, thus, may contain a distinct temper.

The Alma Plain sherd appears to be tempered with trachybasalt porphyry. These grains are characterized petrographically as mostly nonpor-

phyritic with some containing euhedral and subhedral phenocrysts of plagioclase in a very fine grained, felty to trachytic groundmass of potassium feldspar and plagioclase with rare clinopyroxene, magnetite, and altered biotite. Some of the grains show signs of argillic alteration. These grains also match a description of trachyphonolite porphyry given by Moore *et al.* (1988a). Both rock types are found in the northwestern part of the Mescalero Apache Indian Reservation. Trachybasalt porphyry outcrops just east and west of Sierra Blanca Peak. Trachyphonolite porphyry outcrops just east of Sierra Blanca Peak and to the south near Miserable Canyon and the Cienegita Lookout. However, Alma Plain from the Mimbres Valley is also known to contain fragments of trachytic basalt (Hill 1998:37), and a western rather than eastern source is more likely for this sherd, based on the distribution of the type and the NAA data presented below.

The El Paso samples contain higher amounts of silt than the Chupadero and Alma samples. The El Paso Polychrome and El Paso Brown sherds contain roughly the same amount of silt and have nearly identical paste colors. These samples, therefore, were likely made with the same clay source. The Chupadero Black-on-white sherds also have similar paste bodies and thus were also likely made using one distinct clay source.

**LA 6829-1167-557 (Chupadero Black-on-White).** This sherd contains six percent sherd temper and 17 percent sand-sized grains primarily of monomineralic quartz and potassium feldspar and aegirine bearing alkali-feldspar granite. The crushed sherd, or grog, is tempered with monomineralic quartz, potassium feldspar, and alkali-feldspar granite. The paste body appears light speckled in color and contains eight percent silt. The fineness modulus (FM) is 2.51.

**LA 6829-1851-555 (Chupadero Black-on-white).** This sherd contains 16 percent sherd temper and 15 percent sandsized grains primarily of monomineralic quartz and potassium feldspar, shale (maybe natural inclusion), and rare clinopyroxene bearing alkali-feldspar granite and an opaque mineral. The crushed sherd is tempered with monomineralic quartz and potassium feldspar and rare alkali-feldspar granite. The paste body appears light speckled in color and contains six percent silt. The fineness modulus is 2.76.

**LA 6829-1741-468 (El Paso Polychrome).** This sherd contains 28 percent sand-sized grains primarily of monomineralic quartz and potassium feldspar and lithic fragments of alkali-feldspar granite. The paste body appears dark golden brown in color and contains 15 percent silt. The fineness modulus is 2.73.

**LA 6829-876-398 (El Paso Polychrome).** This sherd contains 29 percent sand-sized grains, primarily of monomineralic quartz, potassium feldspar, and lithic fragments of biotite bearing alkali-feldspar granite. The paste body appears dark golden brown in color and contains 17 percent silt. The fineness modulus is 2.58.

**LA 6829-1864-556 (El Paso Brown).** This sherd contains 34 percent sandsized grains primarily of monomineralic quartz, potassium feldspar, and lithic fragments of clinopyroxene or amphibole bearing alkali-feldspar granite. The paste body appears dark brown in color and contains 16 percent silt. The fineness modulus is 2.66.

**LA 6829-1692-411 (Alma Plain).** This sherd contains 34 percent sandsized grains of trachybasalt porphyry. The paste body appears medium golden brown in color and contains eight percent silt. The fineness modulus is 2.53.

### ***Neutron Activation Analysis***

Ten sherds from LA 6829 were submitted for NAA analysis including one Alma Plain, one El Paso Brown, three El Paso Polychrome, two El Paso Bichrome, one Three Rivers Red-on-terracotta, and two Chupadero Black-on-white. Analyses were conducted by Hector Neff from MURR. His methodology is described in Appendix B, while the body of his report is provided here.



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Based on the type designations and other information provided, it was assumed that the most relevant chemical groups to this study would be those defined in studies of El Paso and Mimbres area ceramics, and in our study of Chupadero Black-on-white. This assumption proved to be correct, as shown in Tables 20.8 and 20.9.

These assignments are based primarily on calculation of Mahalanobis distances from the centroid of relevant reference groups, as discussed in Appendix B. A number of bivariate scatterplots of the data also were examined, such as the tantalum-cesium plot shown in Figure 20.9. The probabilities of membership in various reference groups are illustrated in Table 20.9.

The El Paso Brown, Polychrome, and Bichrome sherds all are assigned to the El Paso Reference Group, which would indicate an origin in the immediate El Paso area (Creel *et al.* 2002). Probabilities of group membership are all above five percent and the six samples all plot within the cloud of El Paso Reference Group points on most projections of the data (Figure 20.9).

The two Chupadero Black-on-White sherds fall within the range of variation of previously analyzed Chupadero Black-on-White. A recently completed analysis done for Darrell Creel indicates that Chupadero Black-on-White falls into two broad compositional patterns, both of which have several subgroups. Both of the LA 6829 samples exceed five percent probability of membership in Chupadero-1c, which is one of three subgroups of a larger compositional unit that appears to derive from the Sierra Blanca highlands. Most other Chupadero Black-on-White from the El Paso and Mimbres areas pertains to this same compositional pattern. Darrell Creel is working with a student at Arizona State University, Tiffany Clark, who will be doing additional compositional analysis of Chupadero Black-on-White as a dissertation project.

**Table 20.8 Compositional Group Assignments for Ten Sherds from LA 6829**

| I.D. | Alternate I.D. | Site | Description | Chemical Group |
|---|---|---|---|---|
| ANI012 | LA6829-16 | LA6829 | Alma Plain | Main P. Red Outlier |
| ANI013 | LA6829-18 | LA6829 | El Paso Brown | El Paso Core |
| ANI014 | LA6829-17 | LA6829 | El Paso Polychrome | El Paso Core |
| ANI015 | LA6829-87 | LA6829 | El Paso Polychrome | El Paso Core |
| ANI016 | LA6829-87 | LA6829 | El Paso Polychrome | El Paso Core |
| ANI017 | LA6829-16 | LA6829 | El Paso Bichrome | El Paso Core |
| ANI018 | LA6829-17 | LA6829 | El Paso Bichrome | El Paso Core |
| ANI019 | LA6829-43 | LA6829 | Three Rivers Red-on-terracotta | Unique |
| ANI020 | LA6829-18 | LA6829 | Chupadero Black-on-white | Chupadero-1c |
| ANI021 | LA6829-11 | LA6829 | Chupadero Black-on-white | Chupadero-1c |

**Table 20.9 Probabilities of Reference Group Membership for Ten Sherds from LA 6829**

| | Playa Red | El Paso Core | Chupadero 1a | 1.Chupadero 2b | Chupadero 1c |
|---|---|---|---|---|---|
| ANI012 | 0.62 | 0 | 0 | 0 | 0.001 |
| ANI013 | 0 | 73.16 | 0 | 0 | 0.058 |
| ANI014 | 0 | 26.542 | 0 | 0 | 0.025 |
| ANI015 | 0 | 30.819 | 0 | 0 | 0.001 |
| ANI016 | 0 | 6.083 | 0 | 0 | 0.037 |
| ANI017 | 0 | 83.114 | 0 | 0 | 0.003 |
| ANI018 | 0 | 76.017 | 0 | 0 | 0.001 |
| ANI019 | 0 | 0 | 0.072 | 0 | 0.468 |
| ANI020 | 0 | 0 | 0 | 0 | 98.94 |
| ANI021 | 0 | 0 | 0 | 0 | 5.192 |



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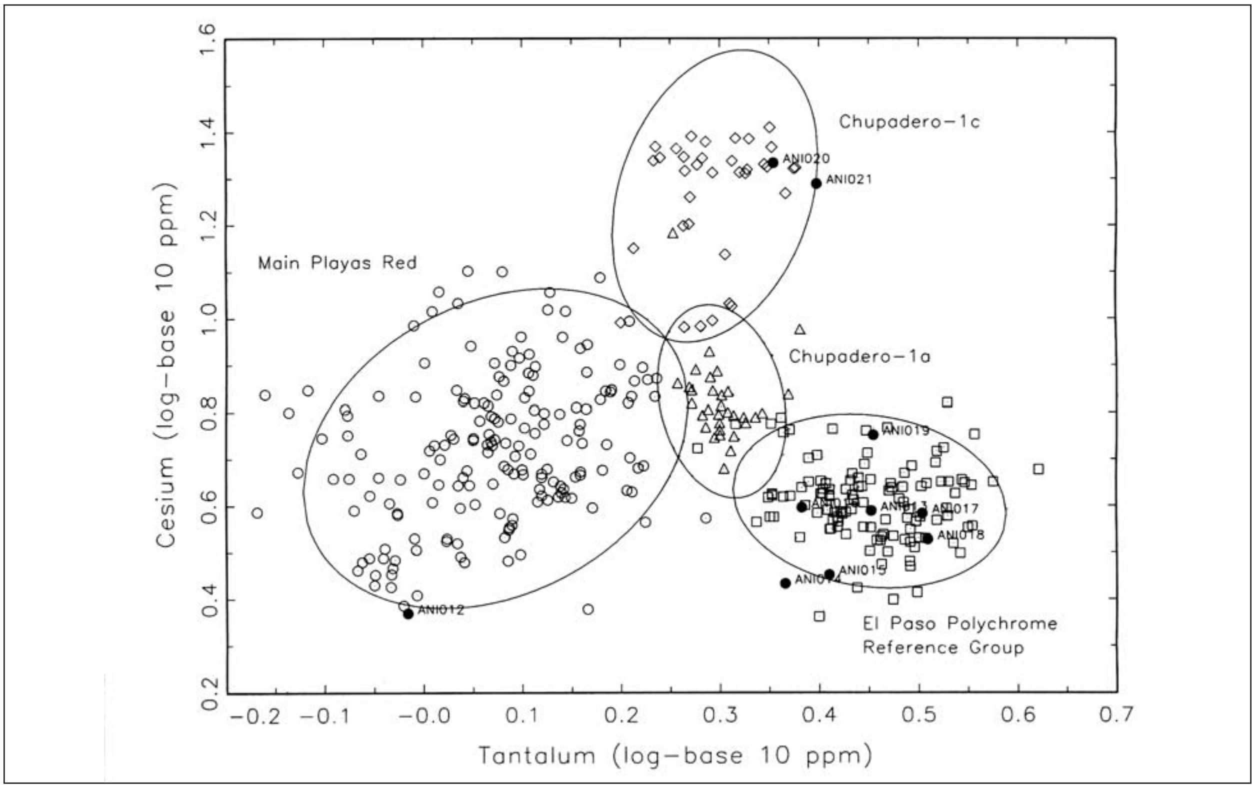


**Figure 20.9 Tantalum-cesium plot of 10 sherds from LA 6829, showing group membership.**

The Alma Plain sherd is on the fringes of the largest compositional reference group from the Mimbres Valley, the Main Playas Red Group. This group subsumes numerous Mimbres Black-on-white as well as Playas Red sherds, and is linked to the Mimbres Valley by several raw material analyses. Although this sample falls just outside the one percent confidence level for membership in the group, Euclidean distance searches of the whole MURR database indicate that its only close matches are members of the Main Playas Red group. Thus, we are confident that the sherd comes from the general Mimbres region.

The Three Rivers Red-on-terracotta sherd could not be assigned to any compositional reference unit in the MURR database. The fact that it falls just outside the one percent level for the Chupadero-1c group in the above table should not be given too much weight because Chupadero-1c has only 35 members, so probabilities tend to be inflated. On many projections of the data it falls within the El Paso Polychrome Reference Group. A Euclidean distance of the MURR databank found that its closest match is an "unidentified red slip" sherd analyzed for Michael Quigg of TRC. We considered that sherd to be Chupadero- or El Paso-related, but did not give a specific group assignment. Speculation that the sherd may represent a localized clay source may be right; it is possible that the clay source will be somewhere not too distant from El Paso.

### ***Discussion of Ceramic Production***

We return here to the original questions. First, what specific locales are suggested as sources for intrusive ceramics, and how diverse are the sources for any one ceramic type? Petrographic and NAA analysis of the most abundant intrusive ceramic type Chupadero Black-on-white, indicates a production locale in the Sierra Blanca highlands. The larger data set from this type that was subject to oxidation analysis, however, com-

plicates this finding. A diversity of paste colors as well as differences that correspond to varied design styles suggests that more than one production locale within the Sierra Blanca region supplies the US 54 sites. The volume of this trade was likely quite large. Extrapolations based on refired color for 209 other intrusive sherds from LA 6829 alone indicate a minimum of 21 vessels are present (see Table 20.7). Given that a total of 780 Chupadero Black-on-white sherds were recovered from the same site, it is safe to suggest that at least 50 Chupadero Black-on-white vessels are represented at the site.

Alma plain from LA 6829 is somewhat off the normal curve for ceramics from the Mimbres area, but still fits this regional source better than others. Although trachytic basalt in one sherd suggested a possible northeastern source, NAA failed to group the sherd with a northeastern compositional group. Instead, it is placed in the Mimbres area but near the outer edge of probability. Color analysis of US 54 Alma Plain, as well as Mimbres Black-on-white, suggest relatively few sources of production, however other ceramics from the region are considerably more diverse. Playas Incised, Playas Red, and Playas Red Incised are quite diverse in color. Also diverse in color and style, and from an unknown NAA chemical group is the Three Rivers Red-on-terracotta found in US 54 sites.

Local ceramic production of El Paso Brownware is indicated by assignment by NAA analysis to the core El Paso chemical group, indicating origin in the immediate El Paso area. Petrographic analysis suggests a relatively uniform, somewhat silty paste and temper ultimately deriving from mountainous areas to the northeast. None of the analytical methods used suggested any differences between decorated and undecorated forms of El Paso Brownware. Thus, production of all three El Paso types by individual potters is thought to have been a common practice. Subtle differences in the ratio of paste colors between the US 54 sites, however, suggest multiple production sources, one of which was almost surely the Jaca site (LA 6829).

## Vessel Morphology and Function

In addition to typological characterization of ceramic assemblages, studies of vessel function comprise another important aspect of ceramic analysis. Not only are sherds and vessels part of a chronological and typological sequence, but they also reflect past activities associated with the use of ceramic containers. Numerous studies of vessel function have been undertaken based on such ceramic attributes as vessel shape, size, appendage, and use-wear (e.g., Jones 1989; Kamp *et al.* 1991; Mills 1989; Schiffer and Skibo 1989; Skibo 1992; Steponaitis 1984). These types of studies assist in interpretation of site and feature function, temporal and spatial change in vessel function, and other areas of research such as household size.

For this study of vessel function, several attributes are discussed to provide an overall picture of ceramic container use at the US 54 sites. These attributes include vessel form, rim radius, vessel appendage, and use-wear. For discussion of these attributes, two data sets are utilized: rim sherds and body sherds. Because breakage of a vessel produces large numbers of body sherds and jars are typically very large, jar body sherds generally inflate the proportion of jars in relation to other vessel types. As a result, using only rim sherds as the primary data set better represents some functional attributes. In the following discussion, rim sherds are used as the data set best representing the overall assemblage and body sherd data are used to supplement the discussion of particular attribute classes (e.g., appendages, use-wear, and postfiring modification).

### ***Vessel Morphology***

Vessel morphology is the first line of functional evidence, as form places constraints on use (Rice 1987). Shallow, flat vessel forms, such as plates, parching trays, and comales (griddles) allow unlimited physical access for cleaning, eating, stirring, and flipping of relatively dry contents, or limited volumes of thin dough; but they are inade-



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quate to handle liquid contents of any great volume. Likewise, these forms are not suitable for storage as they also allow unlimited access for dirt and other debris. Bowls are an ideal container for both dry and wet contents as they again allow unlimited access for cleaning, eating, and stirring; but the broad orifice is risky for long-term storage or transport as it allows spillage and the introduction of dirt and debris. Wide-mouthed vessels provide limited access for cleaning, stirring, and scooping, while the narrower orifice limits spillage. Finally, vessels with a small orifice, especially if necked, are ideal for limiting spillage, but the narrow mouth precludes the introduction of the hand for cleaning, and its contents are limited to those which pour easily, such as liquid and small seeds or meal. These vessels, while ideal for long-term storage and transport, are of limited use in cooking as they preclude the introduction of a stirring implement and could lead to the burning of the contents.

Of the US 54 full analysis sample, 62 percent (n=1940) are jar body sherds, one percent (n=29) are jar base sherds (i.e., bottom of jar), six percent (n=175) are jar rims, 10 percent (n=301) are necks of jars, 13 percent (n=421) are bowl body sherds (including five sherds from the base portion of bowls), seven percent (n=221) are bowl rims, <1 percent (n=2) are from rims of ollas, <1 percent (n=2) are wide mouthed jar rims, <1 percent (n=3) are seed jar rims, <1 percent (n=7) are identified as other or specialty items (including one ladle, five fragments from miniature vessels, and one bead fragment), and <1 percent (n=10) have an indeterminate vessel form (three of which have handle fragments). Because jar body sherds comprise a large percentage of the assemblage and may originate from a number of jar shapes (e.g., wide-mouthed jar, seed jar, or olla), the following discussion of vessel form focuses primarily on rim sherds.

The rim assemblage used in much of the following discussion totals 401 sherds, including specialty items (Table 20.10). Bowl rims comprise roughly 55 percent of the sample, followed by jar rims (42 percent), and ollas, wide-mouthed jars, seed jars, and specialty items each at less than one percent. It should be noted that most but not all of the intrusive ceramics are bowls, but several jar forms, including ollas and seed jars, are unique to the intrusive ceramic assemblage. Other than for ollas, intrusive ceramic types do not seem to have a unique function in the US 54 assemblage, as they duplicate forms commonly found in the locally produced assemblage.

**Table 20.10 Distribution of Vessel Form by Ceramic Type for Rims and Specialty Items from the US 54 Sites**

| Ceramic Type or Generic Type | Bowl | | Jar | | Olla | | Seed Jar | | Wide-mouthed jar | | Specialty Item | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | N | % | N |
| Banded Gray | | | 1 | 100 | | | | | | | | | 1 |
| Chupadero Black-on-white | 38 | 81 | 5 | 11 | 2 | 4 | 2 | 4 | | | | | 47 |
| Corona Corrugated | 2 | 100 | | | | | | | | | | | 2 |
| El Paso Bichrome | 39 | 62 | 24 | 38 | | | | | | | | | 63 |
| El Paso Brown | 22 | 31 | 47 | 66 | | | | | 1 | 1 | 1 | 1 | 71 |
| El Paso Polychrome | 102 | 52 | 93 | 47 | | | 1 | 1 | 1 | 1 | 1 | 1 | 198 |
| Mimbres Black-on-white | 1 | 100 | | | | | | | | | | | 1 |
| White Mountain Red Ware | 2 | 100 | | | | | | | | | | | 2 |
| Three Rivers Broad-lined Red-on-terracotta | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 1 |
| Three Rivers Red-on-terracotta | 15 | 100 | | | | | | | | | | | 15 |
| **Total** | **222** | **55** | **170** | **42** | **2** | **1** | **3** | **1** | **2** | **1** | **2** | **1** | **401** |



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The predominance of bowls over jars is an unexpected finding, but appears to be more a product of vessel morphology than preference. That is, bowl rims are larger than jar rims and break into a greater number of sherds. If all sherds, rather than rims alone, are used to calculate bowl and jar proportions, then it is seen that jars dominate. In Table 20.11, bowl and jar proportions are documented for the locally produced El Paso Brownware, which dominates the US 54 ceramic assemblage.

**Table 20.11 El Paso Brownware Bowl and Jar Proportions**

| Ceramic Type | Bowl | | Jar | |
|---|---|---|---|---|
| | N | % | N | % |
| El Paso Bichrome | 124 | 25 | 380 | 75 |
| El Paso Brown | 45 | 6 | 687 | 93 |
| El Paso Polychrome | 210 | 22 | 734 | 77 |
| Total | 379 | 53 | 1801 | 245 |

The proportions of El Paso Brownware jars noted in Table 20.11 follow that of other Jornada Mogollon sites (Miller 1990), with the exception of the El Paso Brown, which includes an unusually high proportion of jars. As discussed above, jars are more likely to be used for cooking and storage than bowls. Cooking pots tend to discolor rather quickly and are seldom painted, although incising or other forms of textural decoration may be applied. Given the preference for undecorated jars (El Paso Brown) over undecorated bowls, it is likely that a large proportion of the El Paso Brown jars were cooking pots while the decorated jars were more likely to have served as storage jars. This question is explored more fully below, through an examination of size mode and use alteration evidence. Given the tendency for El Paso phase assemblages to contain large numbers of El Paso Polychrome to the exclusion of El Paso Brown, the preference for decorated vessels increased dramatically after A.D. 1200, probably resulting in many decorated vessels used for cooking.

## *Vessel Size*

Rim diameter (cm) and rim arc (degrees) measurements were recorded for all rim sherds in the assemblage large enough to be measured. In most assemblages, not all rim sherds are amenable to diameter and arc measurements for several reasons, including small size, lack of curvature, or irregular curvature. Of the 401 rim sherds identified above, 23 percent (n=91) received diameter measurements. Because all but five of these sherds derive from locally produced El Paso Brownware, these types are the focus of our discussion.

As shown in Figure 20.10, rim diameters are variable by vessel form. Brownware bowls are very standardized. Of the 31 measurable rim sherds, all but one have a diameter between 24 and 30 cm, while 87 percent (n=27) have a diameter of 28 cm. Only one sherd has a significantly different diameter (16 cm). Thus, it appears that a single size mode with an average diameter of 27.5 cm and single standard deviation range of 25.2–29.8 cm was strongly preferred. This size mode was also preferred for imported ceramics. The single measurable Chupadero Black-on-white bowl had a diameter of 26 cm, while the most complete Three Rivers Red-on-terracotta bowl had a diameter of 28 cm. This size mode is significantly larger than that noted by Miller (1990:183) for the El Paso Brownware assemblage from the late Mesilla/early Doña Ana phase contexts investigated in the North Hills Subdivision project. The 45 undecorated bowl rims and eight decorated rims from Miller's assemblage had much smaller mean diameters; 18.8 and 16.3 cm respectively. Thus, his assemblage more closely matches the single smaller bowl from US 54, rather than the larger bowls more typical of the assemblage.

El Paso Brownware jars from US 54 are more variable than bowls in size and, presumably, function. Of the 42 measurable jar rims, 57 percent (n=24) fall between 8 and 10 cm in diameter. This rim size is large enough to admit a small-



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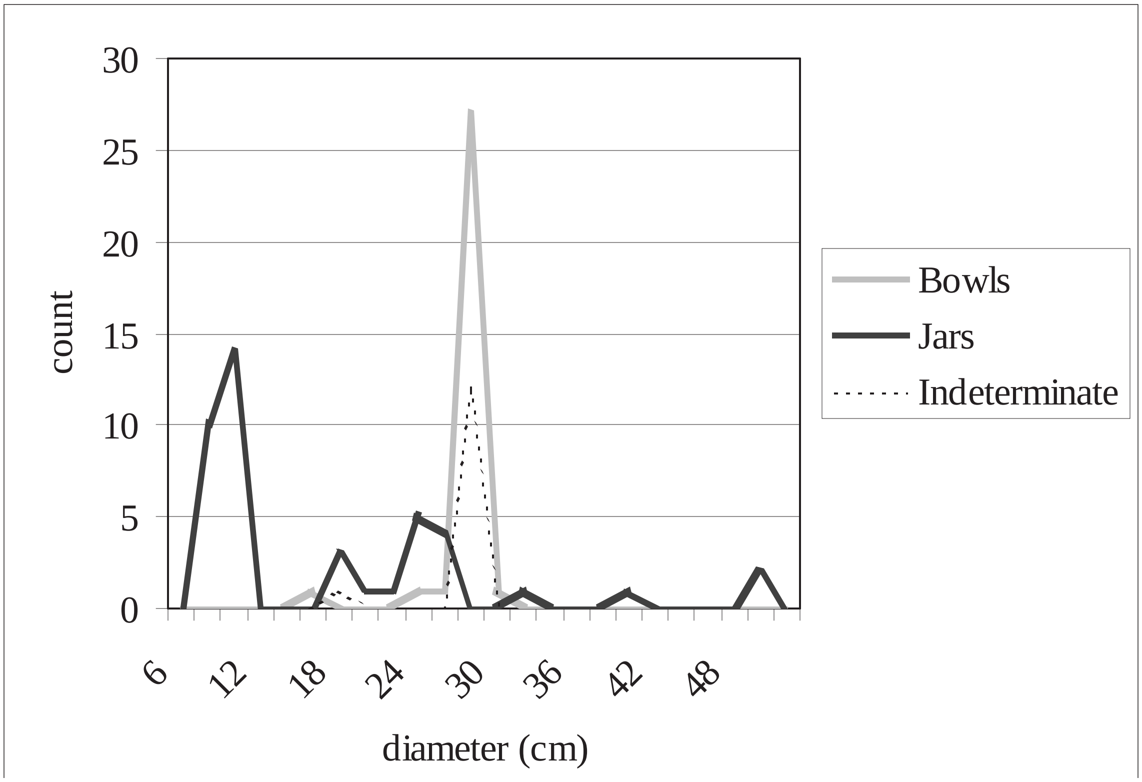


**Figure 20.10 Differences in rim diameters by vessel form for El Paso Brownware.**

sized hand but not large enough to facilitate stirring or the other types of processing commonly associated with cooking. Thus, these small jars are not likely to have functioned as cooking pots; more likely they were small storage jars. A second jar size mode is weakly expressed by nine jar rims (21 percent of the measurable jars) with diameters between 24 and 26 cm. This second size mode fits in well with jars from the North Hills Subdivision; the 71 undecorated jar rims and 32 decorated jar rims from the North Hills assemblage had mean diameters of 23.9 and 22.1 cm respectively (Miller 1990:183). While larger size mode often represents cooking pots, based on greater access for stirring, this is probably not the case for the US 54 assemblage, as all of the jars in this size range are decorated.

Likewise decorated are all measurable rim sherds of indeterminate vessel form seen in Figure 20.10 above. Almost all (92 percent) of the indeterminate rim sherds have a diameter of 28 cm. Thus, they closely fit the profile of bowl sherds, an association that is backed, as well, by the proportion of bowl to jar rims for the total US 54 assemblage, noted above.

The relative paucity of undecorated El Paso Brownware in the US 54 assemblage has been previously noted. It is not too surprising that vessel size modes from US 54 El Paso Brownware are quite different from those of the temporally earlier North Hills Subdivision. US 54 bowls are larger than those of the North Hills Subdivision. They are also primarily decorated (97 percent), while the North Hills Subdivision; bowls are mostly undecorated (85 percent). By contrast, US 54 jars are predominately smaller than their North Hills Subdivision counterparts. Again, they are primarily decorated (98 percent), while only 31 percent of the North Hills Subdivision jars were decorated. Thus, while this study has revealed significant differences between the two El Paso Brownware assemblages in size and, pre-

sumably, function, it appears that the differences are attributable primarily to different proportions of decorated and undecorated ceramic types. The question of why decorated El Paso Brownware appears to be functionally different from undecorated El Paso Brownware is still an unanswered question, especially when it is considered that decorated El Paso Brownware essentially replaces the undecorated by the El Paso phase. But in this regard it should also be noted that all but four of the El Paso Brownware rim sherds from the US 54 assemblage derive from LA 6829, and the size differences noted may be intrinsic to this site alone.

### ***Appendages***

Vessel appendages include a variety of handles and indeterminate lugs applied to vessels during the production process and prior to firing. The US 54 assemblage includes 13 sherds with appendages, eight of which are Chupadero Black-on-white, with the remainder represented by all three forms of El Paso Brownware. All but one of the Chupadero Black-on-white sherds with appendages was a jar with a multiple coil handle (n=6), an indeterminate appendage stub (n=1), or an indeterminate form of appendage (n=1). In contrast, strap handles were most common on El Paso Brownware (n=2), followed by a multiple coil handle (n=1), and two indeterminate appendage stubs. One of the latter occurred on a bowl.

### ***Use-wear***

Ceramic use-wear derives from daily, episodic, and incidental cultural patterns of ceramic usage. Strictly speaking, various dings, scratches, and residues constitute evidence of prehistoric use, while others do not. In order to distinguish culturally meaningful attrition from post occupational damage, the type and location of the attrition must be noted. Mechanical damage, scrapes, scratches, pitting, and small dings are to be expected on those parts of the vessel which receive the most frequent contact rims and primarily exterior bases, but also handles and other appendages. Mechanical damage to the inside of a vessel usually implies use of tool, such as a scoop or stirring stick, or cleaning methods. Thermal damage and soothing may occur during firing, cooking use, or in a post-depositional context. Firing spalls tend to have clean, rounded edges; cooking spalls, caused by escaping steam, are more ragged. Repeated cooking use causes multiple, small thermal spalls on vessel interiors, through time creating a rough, pitted interior. Sooting can occur during cooking use, trash burning, or a structure fire. Residues, pigments, and clays can represent storage and processing, vessel decoration, or incidental post-depositional context. Placement and patterning are critical to the interpretation of the ceramic use-wear noted (Goff and Hensler 1999; Skibo 1992).

Use-wear was observed on less than one percent (n=33) of the total US 54 assemblage (Table 20.12). Most of the use-wear identified in the assemblage consists of sooting, residues, and rim and basal exterior abrasion, with spalling, and interior basal attrition less common. In addition to use-wear placement, vessel form and type provide additional clues to the function of these vessels.

Sooting and interior basal abrasion is most commonly found in plainware jars, both of which are typical use-wear patterns for cooking pots. Exterior basal abrasion is most commonly found on older vessels; and most cooking pots, especially low-fired brownware, suffer too much thermal stress to achieve old age (Arnold 1988; Goff and Hensler 1999). In this regard, all of the plainware jars in Table 20.12 are El Paso Brown, with the exception of a single Alma Plain jar, and it is the Alma Plain jar, that has exterior abrasion. Thus, it appears that locally produced brownware jars are preferred for cooking pots, while imported brownware jars were put to other uses that prolonged their use life. Decorated jars have a greater proportion of mechanical damage than plainware jars, including basal attrition and rim chipping, indicating greater use lives and differing

Table 20.12 Use-Wear and Residue Identified in the US 54 Assemblage

| Use-Wear/Residue | Plain Jar | Decorated Jar | Plain Bowl | Decorated Bowl | Total |
|---|---|---|---|---|---|
| Exterior basal polish, pitting, or abrasion | 1 | 4 | | | 5 |
| Interior basal abrasion | 2 | | | | 2 |
| Red substance | | 2 | | | 2 |
| Exterior red substance | 1 | | | 3 | 4 |
| Rim abrasion | | 3 | | 1 | 4 |
| Sooting on exterior | 4 | 2 | | | 6 |
| Sooting on interior and exterior | 5 | 1 | | | 6 |
| Spalling | | 1 | | | 1 |
| Pigment | | | 2 | 1 | 3 |
| Total | 13 | 13 | 2 | 5 | 33 |

functions. Vessel use lives are typically longer for pots used for storage and/or those used for other purposes only episodically (such as on ceremonial occasions) rather than on a daily basis (Arnold 1988). Basal mechanical damage is found only on the imported type Chupadero Black-on-white, while rim abrasion is seen only on the locally produced decorated brownware. Differences in the hardness of the whiteware and brownware pastes may be responsible for this discrepancy.

Bowls, both decorated and undecorated, are most commonly associated with different types of residues. Three different types of residue were found adhering to US 54 sherds. The first is a powdery white pigment that may have been used for paint, plaster, or other purposes. The exclusive association of this pigment type with bowl forms suggests that the bowls were used either in the preparation of the pigment, or, more likely, as containers for the pigment while it was being applied. Long-term storage appears unlikely, as the open bowl form would allow for the introduction of a great deal of dirt and debris. The second type of residue noted is an iron pigment (limonite) adhering to a ceramic scraper. The third residue type noted appears to be an organic, rather than mineral product. Under the binocular microscope, the residue is reddish in color and somewhat shiny and similar to pitch in appearance. It is associated with a rather odd type of sherd tool, the beveled scraper form (discussed in greater detail below). The two decorated jar sherds with the red substance noted in Table 20.12 are in fact two Chupadero Black-on-white scrapers of this type. The association of this red substance with both plainware jars and decorated bowls is not explicable at this time.

## Sherds as Tools

Vessels are occasionally modified during their use life, and sherds often are modified for use as tools, jewelry, or gaming pieces. Depending on the function of a particular vessel, changes to the vessel body may be made to extend the use life of the vessel or to adapt it to a specific, new function. For example, jars can be modified into bowls, drill holes may be placed near the rim of a vessel for suspension, or drill holes may be placed along the vessel body to repair a break. Sherds are frequently reused as tools or modified into pendants, spindle whorls, or gaming pieces. During analysis of the US 54 ceramic assemblage, evidence of modification after the firing process was subsumed under the analytical attribute of postfiring modification. Sherds with postfiring modification comprise less than one percent (n=235) of the US 54 ceramic assemblage. Of these, 217 derive from LA 6829, 13 from LA 115260, two from LA 128708, and one each came from LA 115260, LA 115265, and LA 126181. The largest proportion of these, 67 percent (n=157), is brownware including El Paso Bichrome, El Paso Brown, and El Paso Polychrome. White ware constitutes 31 percent of the assemblage (n=73) and is represented



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exclusively by the type Chupadero Black-on-white. Playas Red, Three Rivers Red-on-terracotta, and White Mountain Red Ware constitute less than two percent (n=5) of the sherds with postfiring modifications.

The postfiring modifications noted in the US 54 ceramic assemblage can be broken down into three classes including objects, tools, and a class encompassing vessel modifications and repairs. Objects are shaped sherds of either known or unknown function that are complete (i.e., not fragmentary) artifacts. Examples include pendants, gaming pieces, and sherd discs. Ceramic objects are shaped but exhibit no active use-wear, although passive use-wear such as abrasion around the hole of a pendant or random scratches on sherd discs are evident. Ceramic tools either show active use-wear in the form of edge beveling or patterned arrays of notches or scratches, or they conform to ethnographically known tool classes. Examples include scrapers, pukis, spindle whorls, and weaving tools. Ceramic tools may be finely-shaped and ground prior to use, roughly shaped by chipping, or used as found. Vessel modifications include reshaping of large vessel fragments into bowl or ladles, or drilling of the vessel wall to attach rope handles or tie on covers. Vessel repairs are frequently seen in whole vessel assemblages from the Southwest. Repairs include the pitching and sealing of cracks, and often include the bilateral placement of drill holes on either side of cracks. The function of these drill hole sets is best seen on vessel recovered from dry caves and other contexts with good preservation, where cordage is bound, tied, or sewn through holes, usually before the application of pitch.

With whole ceramic tools and vessels, postfiring modifications are relatively easy to classify, but the task is much more difficult with a fragmentary sherd assemblage such as the one from the US 54 project. For example, isolated drill holes could represent a fragmentary spindle whorl or pendant, attempts at vessel repair, or the attachment of a handle. Likewise, very small fragments with shaped edges could represent either objects or tools, because many tool classes exhibit use-wear on a relatively small proportion of their shaped edges. For these reasons, classification of the US 54 assemblage is not exact but contains overlapping classes. Nonetheless, it is clear that different ceramic wares were being used for different purposes.

In Figure 20.11, it is apparent that white ware and brownware ceramics from US 54 show different patterns of postfiring modifications. Isolated drill holes and other indications of vessel repair are much more commonly found on El Paso Brownware than on Chupadero Black-on-white. Small shaped sherds whose exact functions cannot be determined, as well as the ceramic object class, show a slight preference for the locally produced, and much more abundant, brownware. However, the harder and more durable white ware is obviously preferred for the manufacture of tools.

To better describe US 54 objects and tools, each of the major morphological classes was replicated experimentally. Most modified sherds are easily replicable given an abundance of sherds of the right basic form, a large pebble for edge shaping, a lithic drill or sharp flake for drilling, and a flat abrasive rock slab serving either as an anvil or a grinding slab. Broken white ware and brownware sherds from previous ceramic replicative experiments were used for the base material. Four different modified sherd forms were replicated including a spindle whorl, a ceramic disc, two gaming pieces and two scrapers. The most labor-intensive form, a spindle whorl, took 18 minutes to reproduce, while other forms were produced in less than one minute. Modified sherd tools were then manipulated in various ways intended to reproduce use-wear patterns observed on the archaeological assemblage.

Worked sherds are represented in the US 54 assemblage by a single ceramic disc, nine subrectangular gaming pieces, and two shaped objects of uncertain function. All of these ceramic objects

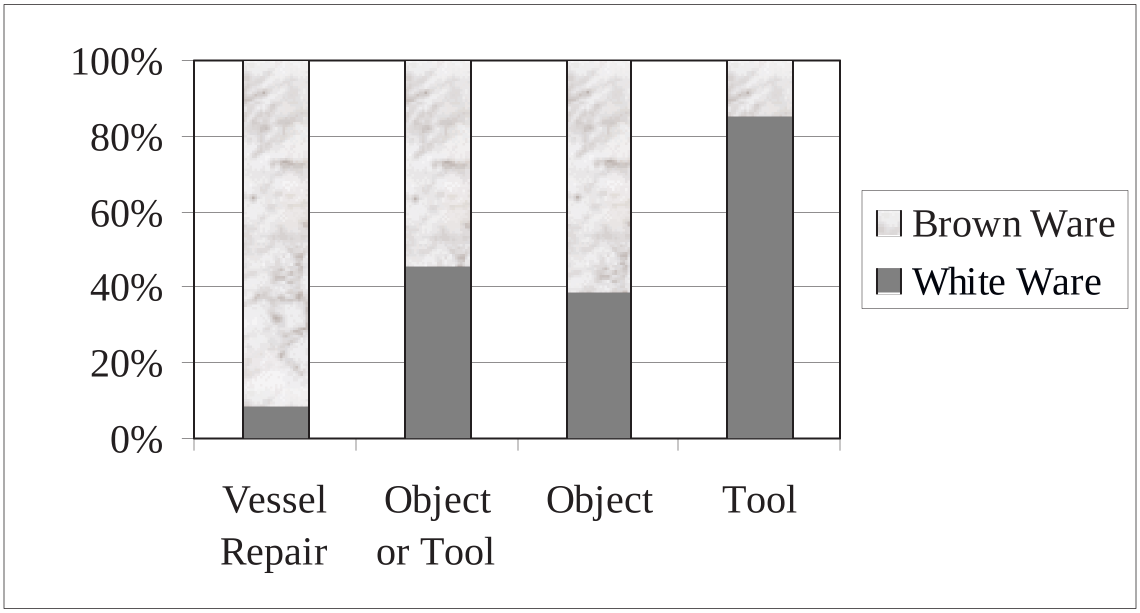


**Figure 20.11 US 54 white ware and brownware postfiring modifications.**

derive from LA 6829. The disc, which is only 70 percent complete, has an apparent diameter of 8.5 cm. Chipping the edges of a large jar sherd into a slightly oval shape made it. Sixty percent of the remaining edge is somewhat rounded while the remaining edge is crisp and unretouched. Miller notes that the most frequent use of modified sherds in the North Hills Subdivision was for digging. "Examples of this form of use have rough, uneven edges with pronounced striations and rounding along their perimeters" (Miller 1990:176). Experimental replication of the disc form took less than a minute using a white ware sherd that was already roughly oval. A subsequent test, digging a small pit, indicates that use-wear is concentrated on the inner edges of the curved disc in the form of rounding, with flaking observed on the outer edge. The more rounded edge of the slightly oval disc received greater use-wear, as it was more helpful in digging. This form of wear is consistent with that observed on the sherd disk from LA 6829, but only if the user was left handed, and the digging episode was fairly short. Other uses for ceramic discs suggested by Oppelt (1984) include pot covers and ceremonial use. The disc was recovered from a non-thermal pit (Feature 147).

The most common modified sherd objects recovered from LA 6829 are small, oblong to subrectangular to slightly trapezoidal gaming pieces (Figure 20.12). These are small pieces ranging 22–47 mm in length, and 16–19 mm in width. Five of the pieces were chipped into shape with no further edge grinding or shaping, two pieces have minimal edge grinding (rounding), and two have been flattened on three edges. The gaming pieces recovered from LA 6829 derive primarily from general contexts, but three are associated with thermal features (Features 35 and 42) and a non-thermal pit (Feature 89), and one was recovered from a structure (Structure 5, Feature 17).

The subrectangular-to-trapezoidal shape of these sherds might suggest that they are unfinished pendants, were it not for the fact that no such completed pendants were recovered from the site. Further, only six of the nine pieces were made from decorated sherds, and their working suggests expedience rather than curation. The roughly formed piece in the middle top row of Figure 20.12 was replicated in one minute and 15 seconds (replica far left top row), while the more formal piece in the middle bottom row took three minutes to replicate (replica again far left). The



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**Figure 20.12 Gaming pieces from LA 6829, replicated pieces far left in each row.**

classification of these modified sherds as gaming pieces (rather than pendant blanks) should not, however, be taken to suggest function. As Oppelt notes (Oppelt 1984:3):

> Many small worked sherds for which no other use is known, are classified as counters or gaming pieces. Although there is some ethnological evidence for this use, it is not known if these games were played in prehistoric times (Culin 1907; Russell 1908). These gaming pieces were made in a great variety of shapes from decorated and plain potsherds during the later time periods in Southwestern prehistory.

Two fragmentary, shaped objects of uncertain function were also recovered from LA 6829. The first is a wedge-shaped fragment made from a Chupadero black-on-white sherd that was recovered from Structure 8 (Feature 119). This object appears to be a reshaped disc fragment with a radius of more than 30 mm. The circular edge is well shaped and smoothly rounded as might be expected for a spindle whorl, while the only other finished edge is ground flat. Since the final edge is not finished, it is unclear whether this object is a fragment from a larger finished piece or a smaller form that was never completed. The second object is a trapezoidal piece measuring 51 x 41 mm that was recovered from a general site context. Three edges on this Chupadero Black-on-white sherd have been ground flat, while two edges are unfinished. In this case, however, it appears that at least one of the unfinished edges is not a fresh break but was simply never finished.

A single fragmentary drilled disc was recovered from the Structure 1 and 2 complex (Feature 54). The whorl has a radius of 39 mm and was created from a Chupadero Black-on-White jar sherd. The sherd was drilled, and the edges were rounded by grinding. Although such drilled discs were commonly used as spindle whorls, Oppelt (1984:3) notes that they were also used as flyweights on pump drills. This was the most time-consuming form to recreate, requiring 18 minutes, most of which were spent drilling the hole. Previous experience in manufacturing and using ceramic discs for cotton spindles indicates that more time is usually spent in forming and finishing the wooden shaft than the sherd whorl. Breakage in manufacturing suggests several critical points. Breakage is most likely to occur during the rough chipping phase or during drilling. Since the rough chipping phase takes less than a minute, and the drilling up to ten minutes (depending on the hardness and thickness of the sherd), less time is lost in replacing broken pieces if manufacturing sequence commences with rough chipping, followed by preliminary grinding, drilling, and final shaping. Symmetry and sherd thickness are critical in creating this form, as an evenly balanced flyweight will spin for a longer period of time. Thus, some preliminary grinding is likely to take place before drilling in case additional chipping is needed to create a better form. Some care needs to be taken in examining broken disc fragments



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from archaeological contexts. Not all need be finished tools; some may represent breakage in the preliminary manufacture of other objects.

The remaining ceramic tools from the US 54 assemblage are either scrapers or indeterminate tools. Two classes of scrapers are seen in the US 54 assemblage: ceramic scrapers and beveled scrapers. Because ceramic scrapers (or *Kajepes* from the Tewa word [Herr 1993]) are used in pottery production, they provide material evidence for on site ceramic production. The six ceramic scrapers from the US 54 assemblage derive from LA 6829, LA 115260, and LA 115262. The two El Paso Brown scrapers from LA 115260 were recovered from the midden deposit at this site (Feature 1), while the El Paso Brown scraper from LA 115262 was found in a thermal feature (Feature 33). The three Chupadero Black-on-white scrapers from LA 6829 were recovered from a thermal feature (Feature 65) and two structures (Structure 1 [Feature 54] and Strucure 14 [Feature 137]). All six scrapers were made from large jar sherds.

Ceramic scrapers are used to smooth coil joins and thin vessel walls during the time when the clay is still quite wet. They are used primarily on the vessel interior; use on the exterior can collapse the vessel wall. For this reasons all ceramic scrapers have convex edges. They are also smoothly finished to prevent any rough edges from gouging the pot. Most scrapers retain a slight curve from the potsherd they were made from. Use-wear on ceramic scrapers is found on both the inner and outer curve of the sherd scraper although use-wears on the outer edge is usually more pronounced. Wear is often uneven and small faceted areas are sometimes found. Drumlins, small areas protected from erosion by protruding temper particles, tail away from the beveled edges of pottery scrapers, indicating the pulling motion of the potters during their use (Waterworth and Blinman 1986).

Ceramic scrapers are easily made; replication of a rough version took three minutes, while a more polished version required five minutes. Thus, it would seem that ceramic scrapers should be more common than the US 54 recovery rate suggests. Yet ethnographic analogy suggests that scrapers used in pottery making were produced from a wide variety of materials, including perishables such as gourds and wood, and the modified sherds recovered from the US 54 sites likely represent only a fraction of those used.

Only two of the ceramic scrapers from the US 54 assemblage are complete enough to determine their outline. A large brownware scraper measuring 78 x 59 mm from LA 115260 is oval in outline (Figure 20.13, left). A Chupadero Black-on-white scraper from LA 6289, measuring 64 x 39 mm is concave on one edge with a French curve on the opposite side (Figure 20.13, right). This odd form creates a resting point for the bony mound at the base of the index finger, making it easier to grasp. Similar shapes have been recorded for Anasazi ceramic scrapers (Herr 1993:Figure 201).

The largest category of scrapers in the US 54 assemblage is the beveled scraper (Figure 20.14). In contrast to ceramic scrapers, these scrapers show use-wear only on the outer edge of the curv-


**Figure 20.13 Ceramic scrapers used in pottery making, from the US 54 ceramic assemblage.**

ing sherd, reflecting a pattern of unidirectional use. In outline these scrapers vary from subrectangular to rounded and many show no shaping at all, merely expedient use of an appropriate-sized sherd. The more complete specimens range 60–80 mm in length, and 42–54 mm in width. The working edges of these scrapers are most commonly straight, but may be rounded or concave, and many are irregular in outline. Striations are oriented perpendicular to, or at a slightly oblique angle to, the edge. The scrapers were used in a pulling motion that resulted in the production of a sharp, clean sherd edge. The edge itself was not used, as none of the examples show any signs of chipping or striations parallel to the sherd edge. Edge angles vary from 60 on relatively new appearing tools to 25 on very worn tools. An angle of approximately 45 is most common.


**Figure 20.14 Beveled scrapers from LA 6829.**

Beveled scrapers were recovered from LA 6829 only. Of the 26 beveled scrapers recovered, 22 were made from Chupadero Black-on-white sherds, two were made from El Paso Brown sherds, and one each was made from Three Rivers Red on terracotta and El Paso Bichrome. Most of the beveled scrapers recovered are rather small fragments suggesting that breakage was a frequent occurrence with this tool class. If so, the preference for the more durable white ware type is explained. Replication of a more formal member of this tool class took somewhat less than three minutes, with no time expended on an unmodified sherd used for the same purpose.

Attempts to reproduce the characteristic use-wear of this tool type provide some clues as to scraper size and the type of materials being processed. The acute use-wear angles seen on the beveled scrapers indicate that the tools were held at an angle that is almost flush with the surface being worked on. Thus, the working surface of the tool is not so much its edge as the flat upper surface of the scraper just behind the edge. This is the reason that very worn tools of this type have abrasion zones that extend back almost 2 cm from the scraper edge. The acute angle of use also explains the width of the beveled scrapers complete enough to measure. The replicated scraper, with a width of 45 mm, was just barely sufficient to allow a tight grip without scraping the thumb across the surface being worked on.

Initial attempts to produce the use-wear observed on the beveled scrapers from US 54 were not successful, leading to further conclusions about the shape and hardness of the materials processed prehistorically. Work on a flat sandstone slab produced a pattern of striations that was much more pronounced than that seen on any of the archaeological tools. None of the tools, however, have the drumlins noted by Waterworth and Blinman (1986) as being characteristic of work on a very soft yielding surface such as wet clay. Thus, scraping of an intermediate hardness-grade material is suggested. Work on the flat sandstone slab also produced a very straight delineation of the top of the abrasion zone, as well as a very flat abrasion surface. While relatively unworn examples of US 54 beveled scrapers show this type of wear, all of the moderately- or heavily-worn scrapers showed a curving delineation of the abrasion zone as well as a slight rounding of the abrasion surface, indicating the surface being worked on was not flat. Replicative experiments with var-



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ious shaped surfaces indicate that the material being worked was most likely concave and somewhat flexible.

Further evidence for the function of these tools is gained by a study of their context. Although eight beveled scrapers were recovered from general contexts at LA 6829, and four were recovered from pits, most (n=14) were recovered from structures, including nine from Structure 1 (Feature 54), four from Structure 5 (Feature 17), and one from Structure 15 (Feature 146). This distribution suggests that this was a very common tool type, and indeed, it is not limited to the Jornada Mogollon. Herr (1993:Figure 203) has documented the use of this scraper type in earlier Anasazi sites from the San Juan Basin, Upper Puerco Valley, and Little Colorado River area. Thus, this tool type is both multicultural and temporally stable in form.

In sum, replication experiments with this tool type suggests that it was used on a fairly soft and flexible material using a hand motion that was nearly flush with the material it was being worked on. Contextual studies indicate that this is a common tool type shared by different cultures. A final clue as to the function of these scrapers is a reddish, pitchy, organic substance that was found adhering to two scrapers of this type. A best guess as to usage probably involves the preparation of organic materials for consumption or use, perhaps the defleshing of yucca for fiber extraction, the production of wooden bowls, or some form of food processing.

## Local and Regional Interaction

Identification of nonlocal ceramics is a primary means of interpreting local and regional distributions of pottery as it relates to social mechanisms such as interaction, intermarriage, economy, feasting, and ceremonialism, among others. Exchange of pottery and the contents of ceramic vessels is often a means of maintaining social relationships. Ethnographic data have shown that commodities such as decorated bowls and cooking pots have distinct functions within the larger context of social interaction (e.g., Cushing 1920; White 1932). Application of ethnographic knowledge to the archaeological record provides a richer background for interpreting social behavior of prehistoric people. Although the historic and modern Pueblo offer abundant ethnographic data, it should be noted that ethnographic analogy is fraught with issues surrounding changes in Puebloan society from religious persecution, slavery, disease, and other cultural factors resulting from the Spanish conquest (Upham 1987).

Archaeological interpretations of social interaction focus on the frequency and distribution of ceramic items identified by various means as nonlocal. The term nonlocal refers to artifacts produced outside of a site, community, or locality. Local geology plays a critical role in determining local versus nonlocal ceramics, particularly with plainware vessels. In most cases, it is difficult or impossible to isolate pottery circulated among local villages, especially in areas of geologic homogeneity. As discussed above, differences in oxidized colors for El Paso Brownware ceramics suggest differences in clay resource exploitation. Although geochemical data may not provide sufficient resolution to segregate clay resources in the greater Tularosa Basin, it is possible that the distribution of yellowish red and red-firing clays may be related to clay resource location and exploitation. If so, spatial distributions of El Paso Brownware ceramics might reflect inter-community interaction. Further research, however, is necessary before the distribution of clays can be fully assessed and further interpretations put forth.

With these types of considerations in mind, ceramics classified as nonlocal (from beyond the Tularosa Basin) include a variety of pottery traditions and types reflecting interaction with people to the north, west, and south of the Tularosa Basin (Table 20.13). The distribution of traditions and types follows a temporal trajectory with less variety during the Mesilla phase and greater variety through time into the El Paso phase. Simultaneously, the distributions through time



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**Table 20.13 Nonlocal Ceramics from US 54 Assemblages.**

| Series | Ceramic Type | Total |
|---|---|---|
| Casas Grandes | Playas Red | 4 |
| | Playas Red Incised | 41 |
| Casas Grandes Total | | 45 |
| Cibola | Banded gray | 1 |
| | Indeterminate White Mountain b/r | 5 |
| | Indeterminate White Mountain Red Ware | 2 |
| | St. Johns Black-on-red | 3 |
| Cibola Total | | 11 |
| Middle Rio Grande | Chupadero Black-on-white | 799 |
| | Corona Corrugated | 7 |
| Middle Rio Grande Total | | 806 |
| Mimbres Mogollon | Alma Plain | 19 |
| | Indeterminate Mimbres Black-on-white | 1 |
| Mimbres Mogollon Total | | 20 |
| Total | | 882 |

also follow changing socioeconomic affiliations resulting in a spatial patterning.

Beginning with the Mesilla phase assemblages, five sites from US 54 were identified as potentially dating to this early ceramic period. Four of the sites (LA 115256, LA 115259, LA 128699, and LA 128708) yielded no evidence of nonlocal ceramics; all of the sherds were identified as locally produced El Paso Brown. LA 115262, however, included 16 sherds of Alma Plain representing 24 percent of the site assemblage. Alma Plain was produced as the primary utility ware in the Mimbres area from A.D. 200–850, spanning much of the Mesilla phase in the Jornada region.

In Lehmer's (1948:77) original description of the Mesilla phase, he indicates that Jornada peoples were in contact with the Mimbres area, and intrusive pottery at the Mesilla phase type site, Los Tules, consisted of Mimbres Black-on-white, San Francisco Red, Mimbres Corrugated, and Alma Plain. He also indicates that many Mesilla phase sites contain no evidence of intrusive wares, further suggesting that contact with the Mimbres areas was either sporadic or not established until late in the phase sequence. It is probable that many Mesilla phase households or communities did not participate in networks of exchange or interaction with the Mimbres region.

Wilson (2000) also identified Mimbres ceramics from a Mesilla phase site (Phantom Palms) near Santa Teresa, New Mexico. Both Alma Plain and Mimbres Boldface Black-on-white were identified in the assemblage. Wilson (2000) suggests that white ware vessels, in particular, from the Mimbres area may have been desirable to Jornada groups who produced only plain brownware ceramics during the Mesilla phase.

Doña Ana phase components from the project include ceramic evidence from LA 6829, LA 115260, LA 115165, LA 126181, and LA 115265. Nonlocal ceramics include 17 Chupadero Black-on-white sherds from LA 128700, three Chupadero Black-on-white from LA 126181, and a minimum of 20 Chupadero Black-on-white and two Alma Plain sherds from five potential Doña Ana phase structures from LA 6829. Several indeterminate Mimbres Black-on-white sherds were identified in the LA 6829 assemblage, probably associated with the Doña Ana phase component.

By the late Mesilla and early Doña Ana phases, production of Mimbres Black-on-white was at its height in the Mimbres Valley. The presence of significant numbers of Mimbres Black-on-white pottery in the Jornada suggests close ties with the Mimbres region. At North Hills I (Miller 1990), the number of Mimbres Black-on-white ceramics clearly shows the influence of Mimbres ideology and society in the Doña Ana phase. Along with Mimbres Corrugated, sherds from the Mimbres region totaled 274 sherds or five percent of the North Hills assemblage.

Shafer (1996) hypothesizes that exchange of Mimbres vessels within the Mimbres region was associated with ceremonial/feasting preparation. The primary Mimbres Black-on-white vessel



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forms are bowls interpreted as food preparation, serving, and storage vessels. Given Shafer's (1996) interpretation of Mimbres bowls as a central part of local and regional feasting, the presence of significant numbers of Mimbres Black-on-white vessels in the Jornada region would suggest an association with feasting and ceremonial practices in that area as well. Shafer (1996) goes on to suggest that the widespread distribution of Mimbres Style III throughout the Jornada may have been associated with mortuary practices (see Hegmon and Trevathan 1996; Thompson 1994), particularly bowls with figurative designs.

The extreme paucity of Mimbres whiteware sherds in the US 54 assemblage may be a temporal indicator reflecting an absence or low-intensity presence of late Mesilla- and early Doña Ana-phase components in these sites. It may also be a spatial indicator, as most of the US 54 sites are located at a greater distance from the Mimbres area than are many of the Mesilla- and Doña Ana-phase sites in the Jornada Mogollon region where Mimbres pottery is found in greater frequencies.

The presence of Chupadero Black-on-white in Doña Ana phase assemblages indicates interaction with more central Rio Grande groups to the north. This unique black-on-white type was most commonly produced as jars, in contrast to the bowl dominated Mimbres Black-on-white tradition. The popularity of Chupadero Black-on-white in the Jornada area may have been more of a utilitarian commodity in contrast to the more ceremonial or feasting association of Mimbres Black-on-white.

By the end of the Doña Ana phase, the Mimbres cultural system had collapsed. Interaction with areas to the west during the subsequent El Paso phase consists of predominantly White Mountain Red Ware from the southern Cibola region. Ten White Mountain Red Ware sherds, including St. John's Black-on-red were identified in the El Paso phase component from LA 6829. White Mountain Red Ware was widely distributed throughout the Southwest during this period and is considered the precursor and model for the earliest glaze-on-red ceramics produced along the Rio Grande Valley by A.D. 1350.

Continued import of Chupadero Black-on-white and Corona Corrugated during the El Paso phase emphasizes the importance of contact between the Jornada and central Rio Grande sites to the north in the vicinity of Gran Quivira (see Hayes *et al.* 1981). Variable tempering materials identified in Chupadero Black-on-white indicate multiple production locales including Gran Quivira, Chupadero Mesa, and the northern Tularosa Basin. Although not identified in the LA 6829 assemblage, Agua Fria Glaze-on-red, the earliest glaze ware, probably was traded along with Chupadero Black-on-white after A.D. 1350.

Finally, Playas Red Incised, originating from northern Mexico, was identified in the LA 6829 assemblage. With the rise of Casas Grandes and its cultural sphere, Playas Red Incised was one of the initial ceramic types from northern Mexico, which made its way north to communities in the Tularosa Basin. Although not present in the LA 6829 assemblage, polychrome ceramics from northern Mexico became common later in the El Paso phase, further emphasizing the importance of interaction networks with neighbors to the south. The absence of these northern Mexico polychromes in the LA 6829 assemblage supports other evidence indicating an occupation time span ending in the early El Paso phase.

Beginning with Mimbres Black-on-white ceramics, occurring in late Mesilla phase contexts and continuing through the Doña Ana phase, ties with other Southwestern culture areas became an important part of Jornada culture. Given the potential of Mimbres Black-on-white bowls for ceremonial and feasting functions, the importance of nonlocal ceramics for specific social contexts may have been established. Continuation and evolution of these social and interaction networks may have characterized subsequent cultural phases in the Jornada. With the decline of the Mimbres system, Jornada groups entered into closer contact with the central Rio Grande and northern Mexico regions for social and economic purposes. The



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distribution of ceramic types and traditions in the Jornada Mogollon area is a material culture reflection of changing cultural interaction networks operating during the Mesilla, Doña Ana, and El Paso phases.

## Summary

The ceramics from the US 54 project offered an opportunity to further examine pottery production and distribution in the Tularosa Basin area of the Jornada Mogollon region. Ceramic components representing the Mesilla, Doña Ana, and El Paso phases were identified during the analysis. Ceramic dates supported by radiocarbon ages indicate five Mesilla phase components: LA 115256, LA 115259, LA 115262, LA 128699, and LA 128708. All of the Mesilla phase components were dated ceramically based on the absence of decorated ceramics and RSI values (specifically for LA 128699). RSI values proved useful in identifying and statistically quantifying Mesilla-phase El Paso Brownware lacking the distinctive rim lip thickening of later Doña Ana- and El Paso-phase brownware.

Five components were identified as Doña Ana phase based on ceramics and supported by radiocarbon ages. These components include Feature 1 at LA 115260, Feature 1 at 115265, Feature 24 at LA 126181, Feature 33 at LA 128700, and Structures 6, 15, and 17 at LA 6829. In addition to radiocarbon age confirmation of a Doña Ana-phase association, stratigraphic placement of the three structures at LA 6829 supports a late Doña Ana-phase component underlying the larger El Paso-phase occupation of the site.

Finally, the remaining features and structures at LA 6829 comprise the only El Paso-phase component identified in the project area. The abundance of El Paso Polychrome rims compared to the relative paucity of El Paso Brown rims at LA 6829 was a useful indicator of an El Paso-phase assemblage. The absence of imports from northern Mexico, such as Ramos Polychrome and Babícora Polychrome, suggests this occupation dates early in the El Paso phase.

Utilization of RSI analysis of the El Paso Brownware rim sherds proved useful in supplementing the ceramic-type and radiocarbon dates, but also revealed some anomalies that probably result from occupations dating primarily late into the Doña Ana phase. Differentiation of Doña Ana-phase components based solely on RSI values proved unreliable for the US 54 assemblages. As mentioned above for the Mesilla-phase assemblages, the low RSI values for these early assemblages were easily teased out from the greater US 54 assemblage. Because the US 54 Doña Ana- and El Paso-phase components appear to cluster tightly in time, the homogeneity in RSI values probably results from the lack of long temporal depth as seen in other studies such as Seaman and Mills (1985), for which a larger number of sites dating over a longer period of time were used.

Based on the sourcing data (oxidation, petrography, and NAA), it appears that multiple clay resources were utilized to produce El Paso Brownware vessels. Differences in oxidized colors for the brownware samples may be indicative either of variable clay resources within procurement distance of the sites or of ceramic exchange among communities in the Tularosa Basin who had access to a variety of clays. Analysis of the worked-sherd assemblage resulted in identification of ceramic production scrapers from LA 6829, suggesting that at least one potter and probably several lived at the site, but the origin of their clay resources remains unclear. Clay resource reconnaissance for the project was hampered by the close proximity of Fort Bliss, and the consequent restricted access to potential clay sources in the area.

In addition to the identification of pottery production scrapers, the worked-sherd assemblage from LA 6829 included a variety of tools and objects, such as scrapers, pendants, gaming pieces, and sherd discs. Analysis and replication of the beveled scrapers provided some insight into their function. We suggest that the wear patterns on these tools were produced by defleshing yucca for



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fiber extraction or in production of wooden bowls, or some form of food processing. Although these scrapers appear to be unique to LA 6829, it is probable that other sites in the Tularosa Basin contain similar tools. A broader study of ceramic scraper tools is recommended to identify spatial and temporal patterning of tool use and food processing practices.

Examination of vessel function data suggests that variation in vessel shape, size, and use occurred through time at the US 54 sites. Compared to Doña Ana phase ceramics from the North Hills Subdivision project (Miller 1990), the size of jars and bowls from LA 6829 in particular shows an increase from that of the Doña Ana phase. Increases in vessel size through time have been suggested for other areas of the Southwest and appear to crosscut wares, vessel forms, and traditions (e.g., Blinman 1988; Crown 1994; Graves 1996; Mills 1989; Spielman 1998). As discussed by Mills (1999), differences in foods cooked, methods of cooking, household size, household wealth or status, and the scale of ritual feasting may influence changes in vessel size.

Finally, interaction and exchange patterns reflected by the ceramic data suggest that the Jornada inhabitants at the US 54 sites had contact with groups to the north, west, and south. Although low in frequency, the presence of Mimbres Black-on-white and culinary wares at the US 54 sites reflects interaction with the Mimbres area. Interpretations of ritual feasting associated with Mimbres Black-on-white bowls in the Mimbres area may also have influenced the development of multi-community ritual and ceremonialism in the Jornada. With the decline of the Mimbres System, Jornada groups appear to have obtained nonlocal wares from the central Rio Grande valley, northern Mexico, and, to a lesser extent, the southern Cibola region.



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Chapter 21

# PREHISTORIC LITHIC ARTIFACTS

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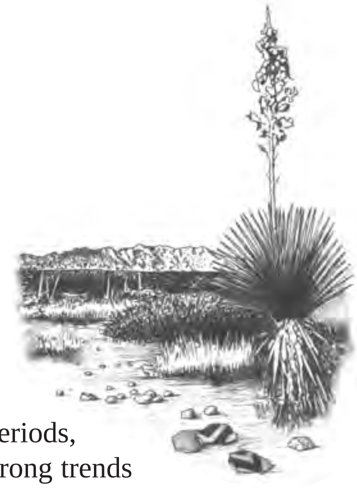

## Goals of the US 54 Lithic Study

This analysis of lithic artifacts, including both chipped stone and ground stone, is designed to provide insight into several primary concerns expressed in the research design (see Chapter 4; Acklen *et al.* 1999): chronology, regional interaction, technology, and subsistence. This analysis addresses the following research issues:

- **Chronology.** Description and discussion of temporally diagnostic artifacts such as projectile points contribute to our ability to place these sites in a larger temporal context. Recovered projectile points range from Late Archaic dart points to Late Formative arrow points.

- **Regional Interaction.** This question is addressed through the identification of probable source areas for lithic materials represented in each site assemblage, as well as x-ray fluorescence (XRF) sourcing of obsidian (see Chapter 22 for detailed discussion). With the possible exception of one piece of obsidian, all lithic materials observed in the US 54 assemblages are available locally within the Tularosa Basin, the surrounding mountain ranges, and the Rio Grande gravels.

- **Technology.** Temporal variation in the production and use of chipped stone and ground stone artifacts is quantified and described. The large volume of chipped stone material recovered from these sites, particularly debitage, provides a wealth of data for examining diachronic variation in lithic production strategies and material procurement practices throughout the project area. Through an intensive debitage analysis, clear changes are observed in chipped stone reduction strategies between Archaic and Formative periods, and especially strong trends are noted in lithic material preferences for both chipped stone and ground stone artifacts. Other research at Jornada sites has seen strong patterns of decreasing chipped stone material quality accompanied by increasingly expedient chipped stone technology during this time (Whalen 1994a; Graves and Miller 2001; Miller 1990).

- **Subsistence.** Both chipped stone and ground stone artifacts are directly related to subsistence practices, particularly food procurement and processing. Patterns of technological variation among grinding implements through time affords an important perspective on the use of plant foods, particularly cultigens. As such, grinding implements enhance understanding of reliance on agriculture.

The analysis in this chapter examines lithic technology in the context of all sites investigated as part of the US 54 project. Characterizations of lithic assemblages at individual sites can be found in individual site description chapters elsewhere in this report.

## Analytical Methods

All analysis of lithic artifacts was conducted at TRC's Albuquerque office under the supervision of Jonathan Van Hoose. One hundred percent of lithic artifacts from all sites except LA 6829 were analyzed. Because of the large quantity of debitage at LA 6829, this assemblage was sampled; see below for a description of the sampling strategy. Lithic artifacts arriving from the field were washed, sorted into broad categories (e.g., debitage, lithic tools, cores, ground stone), and



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bagged according to PNUM (provenience number; every unique provenience has a unique arbitrarily assigned number. This is equivalent to a bag number). Analysis involved recording data relevant to each artifact class on standardized data sheets; analysis protocol and variables for each artifact class are described in detail within each individual artifact section that follows. All data were collected at the level of individual artifact and entered into an Access database for manipulation.

With the exception of debitage and retouched tools, all lithic artifacts were analyzed by a single analyst, Jonathan Van Hoose, to avoid problems of interobserver error. Because several thousand pieces of debitage were collected, four different analysts observed the debitage and recorded data. These include the authors of this chapter and two other, independent analysts. An interobserver error study was conducted to assess the comparability of the data gathered by each; the details of this study are described below in the section on debitage. Retouched tools and some cores were often bagged with the debitage and only identified as tools when examined by debitage analysts, so these were initially recorded by each of the four debitage analysts. Because the numbers of retouched tools (n=110) and cores (n=65) were relatively low, all of these artifacts were then rechecked by a single analyst (Van Hoose) who made any changes in the data necessary to ensure comparability.

### ***Sampling***

Because of the large amount of debitage from LA 6829, this material was subjected to a random stratified sampling procedure resulting in approximately 50 percent sampling of debitage from this site. All lithic artifacts from all other sites were fully analyzed. Sampling of LA 6829 proceeded by selecting 50 percent of the PNUMs (provenience numbers, or individual bags collected in the field) to study, based on a stratified random sampling strategy. Each feature and excavation block constituted a sampling stratum, such that half of the bags from each feature were analyzed, and half of the bags from nonfeature contexts within each excavation block were analyzed. Random numbers were generated in Microsoft Excel and assigned to PNUMs in the bag list within each sampling stratum. PNUMs within each sampling stratum (e.g., feature) were then put into a sequence based on these random numbers, and PNUMs were selected sequentially beginning with the lowest random number until 50 percent of the bags from that provenience had been chosen. In any sampling stratum that contained only a single PNUM, the entire contents of that PNUM were analyzed. A list of the PNUMs sampled appears in Appendix D.

All other artifact types were usually bagged separately from debitage and were therefore not subjected to sampling procedures. In other words, all projectile points, ground stone, bifaces, and other items identified as tools from LA 6829 were analyzed fully. In addition, any tools or non-debitage artifacts that were noted incidentally in nonsampled debitage bags were removed by analysts and analyzed as well. However, the fact that some tools were not identified as such during the field or washing stages of artifact processing means that an unknown number of tools remain unnoticed in nonsampled debitage bags. For this reason, we avoid and caution against any analysis of material from LA 6829 that combines debitage and tool data (such as examining ratios of formal tools to utilized flakes), as the assemblage is surely skewed slightly toward tools.

### ***Statistical Methods (Chi-square and Adjusted residuals)***

For parts of the following analysis, particularly the analysis of debitage, the variables of interest were compared to one another using a chi-square test of significance. Since its first use by Spaulding (1953), chi-square has been one of the most frequently used statistical techniques in archaeology. However, the results of a significant chi-square only indicate differences between rows and columns of counts from categorical data, and

does not identify the specific variable(s) that is (are) causing the significant result. Examination of the adjusted chi-square residuals is useful for understanding which specific variables are responsible for causing a chi-square to return a significant result. For each cell, the adjusted chi-square residual provides a value ranging from -∞ – +∞. Values above +2 or below -2 indicate significant deviations from the expected value, and can be roughly read like standard deviation units. For these analyses, chi-square values were calculated and deemed significant at the 0.05 level. For significant chi-squares results, plots of adjusted chi-square residuals were produced to tease out the significant variables. These charts are presented as either bar charts for nominal level variables (e.g., flake completeness and material type) or line charts for ordinal level variables (e.g., flake size, percent cortex, and platform type).

### ***Sites with Multiple Components***

Some individual sites represent multiple occupational components, sometimes separated by large periods of time. In conducting this lithic analysis, we attempted to separate the artifacts produced by different components where possible. Because several sites have relatively small lithic assemblages, lumping together sites from the same broad periods for analytical purposes increases our ability to describe temporal differences by increasing our effective sample sizes from Late Archaic and Formative periods. This discrimination of components within sites was conducted as follows.

A within-site distributional analysis of surface lithics was conducted to examine the potential for spatial patterning between different temporal components. For this analysis, surface artifacts were used because 1) they have specific provenience information (either piece plotted or collected within surface collected grids), and 2) they provide spatial information across the entire site, unlike the more selectively placed subsurface excavations. Based on initial results of the debitage analysis, it was clear that certain material types, such as rhyolite and chert, more frequently were associated with Archaic assemblages, while Formative-period assemblages contain more silicified shale and some other materials. For each site with significant surface deposits, a plot of the flakes by material type was created using each flake as a data point. Of particular interest was finding and separating out individual components within multi-occupation sites. In this analysis, three sites in particular contained signatures of Archaic sites (such as a large number of chert flakes) but also contained Formative-period ceramics and/or features. These sites are Orogrande 1 (LA 128699), Orogrande 2 (LA 128700), and LA 115262. To help segregate Archaic from Formative-period assemblages, plots of surface ceramic finds, pithouses, and radiocarbon-dated features were added. For LA 115262, there was no spatial separation between signature lithics and ceramics, or between lithics and Formative-period C14 dates. Therefore the entire assemblage was defined as “mixed.” For LA 128699 and LA 128700, chipped stone clusters were identifiable that *were* spatially distinct from the Formative-period ceramics and radiocarbon-dated features. In the debitage section of this chapter, in which different temporal components are compared, it will be shown that the characteristics of the lithics separated out from LA 128699 and LA 128700 are quite distinct technologically, lending credence to the conclusions of this spatial analysis. See Chapters 14 and 15 for more specific information on the spatial patterns at LA 128699 and LA 128700, respectively, including maps of the surface distributions. In sum, for these two sites the spatial analysis proved very useful in segregating out the Archaic components from the Formative ones.

Distributional studies of ground stone at LA 128699 and LA 128700, however, failed to show any appreciable spatial separation between Archaic and Formative components. There are no clear spatial differences in ground stone artifact type or material type at either of these two sites;

however, the majority of ground stone from both sites originated from the portions designated as "Archaic" according to the distribution of surface artifacts and radiocarbon dates. For this reason, all ground stone artifacts from LA 128699 and LA 128700 will be lumped into a "Mixed Archaic" category for comparison to Formative assemblages.

### Lithic Materials

A variety of lithic material types appear in the US 54 assemblages, but four materials are present in especially large amounts: chert and silicified shale are the most common chipped stone materials, and sandstone and granite dominate the ground stone. With the exception of obsidian, all materials observed are found within the Tularosa Basin or the mountain ranges that bound it and should be considered local materials. According to geochemical sourcing studies, all but one piece of collected obsidian originate from sources found in the Rio Grande gravels, and as such are also obtainable near the project area. No evidence was found for materials that could not be easily procured within a maximum of 60 km from the project area, and many materials are available at much shorter distances—within 20 km of any given site.

Nonetheless, these materials are not distributed evenly across the landscape. It is still probable that some materials are more locally abundant in some areas than other materials; this is likely for "silicified shale," which shows a significant prevalence at Formative sites relative to Archaic sites. The source for this material is likely very close to LA 6829, and forms the majority of the chipped stone assemblage at that site. Further, abundance of silicified shale drops off steadily as distance from LA 6829 increases; this pattern is true for all sites except LA 128699 and LA 128700, both of which have strong Late Archaic components and are dominated by chert. It is likely that this difference is largely due to greater Archaic mobility and larger group territories, which gave these populations more ready access to chert deposits within the project area, as well as greater preference for high-quality toolstone during the Archaic period. See the debitage section of this chapter for further discussion of this pattern. Numerous other studies in the Jornada area also see a trend away from high-quality cherts in use during the Archaic toward lower-quality, coarser materials during the Formative (Carmichael 1986; Whalen 1994a).

#### ***Calcite***

One stone bead of this material was recovered from LA 6829. This is a carbonate mineral common throughout the project area, including sources in the Jarilla Mountains (Schmidt and Craddock 1964:31). It is a common material used in stone bead manufacture (Church *et al.* 1996:123)

#### ***Chert***

Cherts, a catch-all term for a wide variety of cryptocrystalline silicates (CCS) and microcrystalline silicates, are found in numerous sedimentary and chemically precipitated contexts throughout the project area and surrounding regions and constitute one of the two most common lithic materials in the project area. At least 15 chert-bearing formations are identified in a study by Church and his colleagues of Jornada lithic materials found throughout south-central New Mexico, westernmost Texas, and northern Chihuahua (Church *et al.* 1996:64–80). In particular, Carmichael (1986:168) notes dark red to dark brown jaspers originating in the Jarilla Mountains, and chert nodules are common throughout the Pennsylvanian strata in the Jarillas (Schmidt and Craddock 1964:6). Chert is one of the most easily available and highest-quality stone materials exploited by prehistoric inhabitants of the project area and is found at all sites. Carmichael (1986) notes a preferential abundance of cherts at Archaic sites, a pattern which is consistent with the US 54 data and will be addressed further in this chapter. The association between Archaic occupations and finer-grained, high-quality chipped stone materials such as chert is well

established for this region. In a large-scale survey of the Tularosa Basin, Carmichael (1986) notes a trend away from finer-grained materials through time; chert (excluding Rancheria chert) was the most prevalent material type at Archaic sites, but later phases shifted in general to coarser rhyolites and other materials (Carmichael 1986:184–188). This pattern of higher-quality materials exploited during the Archaic is one common throughout the Southwest and within the Jornada region (Whalen 1994; Carmichael 1986) and is similar to one noticed in a recent study in the Big Burro Mountains of southwest New Mexico (Van Hoose 2000).

All cryptocrystalline materials have been grouped together for the purposes of this study into the category "chert." This includes all colors and degrees of opacity. There is such a wide range of variation in the cherts examined in this project that it was not feasible for the four analysts to maintain interobserver comparability. The vast majority of cherts observed in the US 54 assemblages are brown to grayish-brown, but chalcedonies (in the archaeological sense, translucent cryptocrystalline silicates) as well as additional colors are also present in smaller amounts.

**Rancheria Chert**

Despite the fact that analysts did not generally distinguish varieties of chert from one another, one locally available chert was distinctive enough that it could be identified rather easily. This is Rancheria chert, originating in limestone deposits within the Rancheria Formation and found in the mountain ranges bounding the Tularosa Basin and Hueco Bolson: the Franklin Mountains southwest of the project area; the Hueco Mountains south of the project area; and Bishop Cap and Rattlesnake Ridge to the west of the project area (Carmichael 1986:163, 167). This material is often coarser than most cherts (medium-grained, indicating a rough texture but with grains still too small to be seen without magnification), generally light brown with grayish mottling or gray lines cross-bedded throughout. While the analysts probably did not consistently identify this material, its presence at US 54 sites is nonetheless relevant to patterns of procurement and use. Rancheria chert was specifically identified in small quantities at LA 115255, LA 115259, LA 115260, LA 126181, and LA 128699. All of these sites are in the northern portion of the project area, in the area around the Jarilla Mountains. Although the total observed lithic assemblage at LA 126178 was small, Rancheria chert made up a significant proportion of the lithics observed at that site; see Chapter 17 for more detailed discussion of this assemblage.

### ***Granite***

One of the two most common materials used for ground stone tools, granites are plentiful in the mountains throughout the project area, including the Jarilla, the Organ, and Hueco mountains (Schmidt and Craddock 1964; Church *et al.* 1996; Carmichael 1986). Granitic rocks in the US 54 assemblages are coarse in texture, with colors typically in the tan to pink range and sometimes extending into darker browns. This material was most commonly used for ground stone artifacts, particularly milling implements such as manos and metates; Carmichael notes a greater abundance of this material in Formative ground stone assemblages when compared to Archaic, and this pattern is corroborated by the US 54 data. See the ground stone section in this chapter for further discussion.

### ***Hematite***

One piece of hematite, likely used as a pigment, was recovered from LA 115260. Hematite is found in massive beds in the Jarillas (Schmidt and Craddock 1964:46–47) as well as in portions of the Organ Mountains (Church *et al.* 1996:120).

### ***Hornfels***

See discussion of "silicified shale."

### ***Limestone***

Limestone is common in sedimentary formations throughout the project area, particularly in the

Jarilla Mountains, dominating both the Pennsylvanian and Permian deposits there (Schmidt and Craddock 1964). The indurated limestone found in the project assemblages is soft, medium to coarse in texture, sometimes fossiliferous, and easily weathered. Several pieces of limestone were recovered that appear in general to be shaped like cores or other artifacts, but which have surfaces so rounded and weathered that individual flake scars cannot always be identified. Limestone was usually identified in this project by the application of dilute hydrochloric acid (HCl).

### Mica

An unworked piece of biotite, a dark variety of mica, was collected from LA 6829. Biotite occurs in metamorphic and intrusive igneous rocks and likely originates from the Jarilla Mountains or from igneous or metamorphic contexts in surrounding mountain ranges.

### Miscellaneous Igneous

This designation was used for any material that was obviously of igneous origin, but not easily placed into a specific rock type. These materials range in texture from fine to coarse, and likely include both intrusive and extrusive igneous rocks. The designation was rarely used.

### Obsidian

Obsidian, or volcanic glass of rhyolitic composition, is a high-quality, chipped stone material very rarely found in these assemblages; only 16 pieces of obsidian were observed. In order to identify geological source areas for these materials, 14 pieces were submitted to M. Steven Shackley of the Berkeley Archaeological XRF Lab at the University of California for x-ray fluorescence sourcing (XRF).

With the exception of a single piece from an unknown source, all US 54 obsidian samples submitted for XRF derived from the Cerro Toledo (in the Jemez Mountains) and Mount Taylor sources. The primary sources are quite distant from the project area, but secondary alluvial deposition of materials from both sources are abundant in the Rio Grande drainage basin and have been identified in the Rio Grande gravels as far south as Chihuahua. Thus, while these obsidians are not found immediately within the project area, they would be available to people traveling to the Rio Grande south of the project area. The materials may also be present in outwash gravels of the ancestral Rio Grande in the southwestern corner of the Tularosa Basin. These therefore should be considered somewhat less local than the other lithic materials described here, but not indicative of travel over great distances.

A single piece of obsidian from LA 6829 could not be correlated with any known geochemical source; Shackley considers it likely that this originated at one of the many undiscovered sources in northern Mexico. If this is the case, it would represent the only instance of obviously nonlocal lithic material recovered during the course of this investigation. See Chapter 22 for a detailed discussion of the XRF analysis.

### Quartz Crystal

A small number of euhedral quartz crystals were recovered from LA 6829, and four pieces of debitage apparently struck from quartz crystals were identified at LA 128699. Quartz crystals are found in both metamorphic and igneous deposits throughout the region, including within the Jarilla Mountains and Organ Mountains (Schmidt and Craddock 1964; Church *et al.* 1996:124), as well as in the Rio Grande gravels (Church *et al.* 1996:124).

### Quartzite

Quartzite is a general term for a range of materials composed largely of quartz, usually in the form of quartz sand cemented by silica (Church *et al.* 1996:76). Quartzites are divided into two groups: orthoquartzite (unmetamorphosed, highly cemented quartz sandstones) and metaquartzite (metamorphosed sandstone). These are often very difficult to distinguish visually and are not

differentiated in this analysis. Quartzites are found in the Organ and Franklin Mountains (Carmichael 1986:166) as well as in alluvial and lag deposits in the Rio Grande. Quartzites identified in the US 54 assemblages are generally medium to coarse-grained gray to bluish-gray, weathering to a light brown cortex.

### ***Rhyolite***

Rhyolites, a general term for nonglassy extrusive igneous rocks with a high silica content, are found in the Franklin, Organ, Robledo, Doña Ana, and Sacramento Mountains, as well as in some of the Rio Grande gravels. Different varieties of rhyolite were not as a rule distinguished during the course of the analysis, but types such as Soledad rhyolite and Franklin rhyolite were identified at some sites. Rhyolites observed in the US 54 assemblages range from aphanitic to porphyritic, and range from white, light pink and tan to nearly black. Soledad rhyolite originates in the southern Organ Mountains (Church *et al.* 1996:99), and Franklin rhyolite is found in the Franklin Mountains east of the project area. Soledad rhyolite is slightly porphyritic, generally pink or grayish-pink with feldspar phenocrysts. Franklin rhyolite is also porphyritic, with a fine-grained dark brown to black groundmass and quartz phenocrysts. In addition, a rhyolitic material with a white to light tan, medium-grained groundmass and feldspar phenocrysts was noted in relative abundance within the assemblage at LA 128699. Except for color, this material is very similar to Soledad rhyolite and may be a variety of it. Franklin rhyolite was most abundant at LA 115262, and Soledad rhyolite was identified in small amounts at LA 115260, LA 115265, and LA 128700.

### ***Sandstone***

Sandstone is one of the two most common materials used for ground stone artifacts and is widely available throughout the, Franklin, Organ, and Jarilla Mountains (Carmichael 1986:169; Church *et al.* 1996:108–110; Schmidt and Craddock 1964:12, 20). Carmichael (1986) notes a greater abundance of this material in Archaic ground stone assemblages when compared to later Formative assemblages. See the ground stone section in this chapter for further discussion.

### ***Schist***

Several small fragments of schist, initially identified as noncultural, were noted at LA 128700 (n=12). This metamorphic material is greenish-brown, highly foliated, and extremely coarse. The pieces observed in the LA 128700 assemblage were not identified as cultural at first because of the material's extremely blocky cleavage, such that even intentionally struck pieces would not exhibit identifiable flake characteristics. The presence of the material at the site was noted as unusual by analysts, and these items were kept; however, some pieces were discarded during analysis as noncultural before this pattern was noticed. Carmichael (1986:170) notes the existence of pestles made of schist in sites within the Tularosa Basin, and notes a source in the northern Organ Mountains approximately 40 km west of LA 128700; Church *et al.* (1996:111) note the unconfirmed existence of a second source in the Franklin Mountains. It is unlikely that this material occurs naturally at or near the site, and thus we determine that its presence is the result of human transport.

### ***Silicified Shale***

Silicified shale is one of the two most common chipped stone materials found in the US 54 assemblages. It was identified only during the data recovery phase, and surely includes many items tentatively identified as other materials during the testing phase. This material is gray to greenish-gray, often banded and highly siliceous but of widely variable fracture properties, ranging from chertlike isotropic fracture to highly blocky cleavage along solution joints and sedimentary layers. Small inclusions of garnet and biotite have been noted in some pieces. This material is certainly the same described by Carmichael (1986:168), which he identifies as silicified

Pennsylvanian siltstone or shale occurring in deposits on the western portion of the Jarilla Mountains and in the Organ Mountains to the west. Similar materials have also been noted in other parts of the Jarillas (Schmidt and Craddock 1964), as well as in the central Sacramento Mountains (Church *et al.* 1996:82). Carmichael's map showing the locations of sites containing silicified shale (which he sometimes calls indurated shale) suggests clustering of this material near the Jarilla Mountains and the Organ Mountains to the west, with much lower prevalence in the lowland center of the Tularosa Basin (Carmichael 1986:175).

Carmichael (1986:162) notes that this material is associated with volcanic intrusions into Pennsylvanian and Permian deposits in the Organ and Jarilla Mountains. While not explicitly stated by Carmichael, this suggests that some degree of metamorphic alteration is responsible for this material. Depending on the type and degree of alteration, this could technically make this material a type of hornfels, (a shale altered by contact metamorphism, often characterized by very weak alteration sometimes difficult to identify macroscopically). Indeed, descriptions of hornfels in the Jarillas found in Schmidt and Craddock (1964:31) match this material quite closely, describing it as a light-green, massive, hard rock with minor inclusions of garnet. In addition, the basal portions of Permian siltstone and shale are metamorphosed into a "flinty hornfels" in the southern portions of the Jarillas, particularly in the area just west of Orogrande, very near LA 6829 (Schmidt and Craddock 1964:13). It is possible that this is a primary source for the abundant silicified shale found at that site. Church *et al.* (1996:103) describe Jarilla hornfels as green to gray, but do not address the possible equation of this material with Carmichael's silicified shale.

Inconsistency in the identification of this common material appears widespread in the literature. This is not uncommon; hornfels is often not recognized by archaeologists and is likely underrepresented (Church *et al.* 1996:103). Particularly in its more fine-grained forms, this material might be referred to as gray chert in other reports and is sometimes referred to as siltstone (cf. Acklen *et al.* 1999).

Carmichael's 1986 survey of 6,061 archaeological sites in the Tularosa Basin identifies this material as preferentially prevalent in Pueblo-period assemblages, a pattern strongly supported by the US 54 data and discussed in greater detail throughout this chapter. Despite its chertlike qualities, the present analysis never lumps silicified shale with cherts and other cryptocrystalline silicates due to its distinctive visual characteristics and fracture properties.

### *Slate*

Like hornfels, slate is a clay or shale altered through contact metamorphism, likely originating from the Jarilla Mountains. Only one piece of slate was recovered during US 54 investigations, from LA 6829.

### *Turquoise*

Four small pieces of unworked turquoise were recovered from LA 6829. Church *et al.* (1996:127) report a "significant turquoise source" in the Jarilla Mountains, which was exploited prehistorically and may have been linked to the Casas Grandes trade system.

### *Other Materials*

#### Historic Glass

A single, very poorly worked biface recovered from LA 128709 is made of clear, historic glass.

## Chipped Stone Artifacts

### *Projectile Points*

Projectile points are defined here as pointed chipped stone artifacts (usually bifaces) with hafting elements. Projectile point forms have long been an important source of chronological information because of the temporally sensitive nature of point design and form. For the purposes of this analysis, all projectile points were examined with respect to two classes of information: cultural-historical type and morphological data. Data record-

ed for projectile points include the following variables: material type, cultural-historical point type, technological type (arrow or dart, based on size and thickness), evidence for heat modification (altered luster, heat spalls, crazing, other, or absent), completeness (described in narrative fashion to be as specific as possible), location of reworking, notch position (corner, side, base), and base shape (concave, convex, straight, or irregular). Also recorded were a set of metric measurements designed to precisely characterize projectile point morphology for broad comparative purposes without regard to cultural-historical types. This set of attributes was presented in Thomas's (1981) discussion of Monitor Valley, Nevada projectile points. While developed for use with Monitor Valley points, these measurements are in no way specific to any cultural-historical context and are designed to be free and independent descriptors of point morphology without respect to any specific time or place. These attributes include: *distal shoulder angle* (DSA) and *proximal shoulder angle* (PSA), both measured in degrees from an imaginary line established perpendicular to the longitudinal axis of the artifact. PSA measures the angle from the perpendicular line to the proximal margin of the notch, while DSA measures the angle from the perpendicular line to the distal notch margin. Angles were measured with a contact goniometer. Also measured was the *maximum width position*, expressed as the ratio of the distance between the base and point of maximum width to the total length of the point. Finally, the metric attributes of length, width, and thickness were measured to the nearest millimeter with a pair of calipers on intact dimensions only, and weight was determined with an electronic balance.

Only sixteen projectile points were recovered from six sites, ranging from Late Archaic dart points to Late Formative arrow points (Table 21.1). All are made from high-quality, fine-grained materials, mostly chert (n=12), followed by rhyolite (n=3) and obsidian (n=1). While all other artifact classes show a decrease in the use of cherts and fine-grained materials through time, this sample suggests that projectile points were preferentially made of such materials even during the Late Formative.

No single projectile point typological sequence has been developed for the Tularosa Basin (O'Hara 1988a:191); researchers have used a combination of types identified in adjacent regions ranging from west Texas to Arizona. In this study, points were assigned to cultural-historical types based on a variety of criteria, including published descriptions and comparison of overall form to published illustrations. All point types described here have been reported in surveys of the Tularosa Basin (Carmichael 1986; Seaman *et al.* 1988).

#### Archaic and Early Formative Types

Archaic point types are all thought to represent dart points, and are usually larger and thicker than the points typically used on arrows. Points of the following Archaic types were identified in the US 54 assemblages; date ranges for some extend into the Formative period.

**Ellis.** The Ellis point type spans the Late Archaic–Formative periods. The type is described as having a short triangular blade with prominent shoulders, frequent corner notching, with an expanding stem and straight to convex base (O'Hara 1988b:302). This type has been reported throughout Texas and the eastern portions of New Mexico, with date ranges including 1000 B.C.–A.D. 1000 (Dorshow *et al.* 2000:73) and A.D. 500–1000 (O'Hara 1988b:302). A single Ellis point was identified at LA 6829, a Formative assemblage. Figure 21.1, A.

**Martindale.** This type is associated with Early to Middle Archaic occupations in central Texas, but with a wide date range (O'Hara 1988b:297), and is characterized by a triangular shape, and an expanding stem with a slightly concave base. According to the Border Star survey report (O'Hara 1988b:297), dates range from approximately 4000 B.C.–A.D. 1900. One point possibly

**Table 21.1 Projectile Points Recovered from US 54 Sites**

| Site | PNUM | Point Type | Technological type | Point Temporal Affiliation | Recovery Context | Material |
|---|---|---|---|---|---|---|
| 6829 | 123 | Harrell | Arrow | Late Formative | Formative | Chert |
| 6829 | 508 | Ellis | Dart | Late Archaic/Early Formative | Formative | Chert |
| 6829 | 897 | Fresno | Arrow | Late Formative | Formative | Mount Taylor obsidian |
| 6829 | 1331 | Fresno | Arrow | Late Formative | Formative | Chert |
| 6829 | 1502 | Notched flake | Arrow | Indeterminate | Formative | Chert |
| 6829 | 1585 | San Pedro | Dart | Late Archaic | Formative | Rhyolite |
| 6829 | 1787 | Harrell | Arrow | Late Formative | Formative | Chert |
| 115260 | 34 | Unidentified | Dart | Possible Archaic | Formative | Chert |
| 115260 | 146 | Cienega | Dart | Late Archaic/Early Formative | Formative | Chert |
| 115260 | 154 | Scallorn | Arrow | Late Formative | Formative | Chert |
| 115260 | 230 | Martindale | Dart | Early to Middle Archaic | Formative | Chert |
| 115260 | 233 | San Pedro | Dart | Late Archaic | Formative | Rhyolite |
| 128699 | 401 | San Pedro | Dart | Late Archaic | Archaic | Chert |
| 128700 | 9 | Palmillas | Dart | Late Archaic/Early Formative | Archaic | Chert |
| 128708 | 3 | San Pedro | Dart | Late Archaic | Mixed | Chert |
| 128709 | 6 | San Pedro/Cienega | Dart | Late Archaic/Early Formative | Mixed | Rhyolite |

associated with this type was recovered from LA 115260. Figure 21.1, B.

**Palmillas.** Dates for this type are reported as 1000 B.C.–A.D. 1000 (Dorshow *et al.* 2000:73) or A.D. 1–1000 (O'Hara 1988b:300), indicating that it straddles the Late Archaic/Formative boundary. These points have leaf-shaped to triangular blades, with small rounded stems and convex to straight bases, and have been identified from northern New Mexico southward into Mexico (O'Hara 1988b:300). The US 54 Palmillas point was recovered from LA 128700, a mixed Late Archaic/Formative site. Figure 21.1, C.

**San Pedro and Cienega.** These point types are found throughout the American Southwest and are characteristic of Late Archaic/Early Agricultural occupations. San Pedro was first identified by Sayles and Antevs (1941) and typically consists of a relatively long blade with weak to deep side (or slight corner) notches with a relatively wide, rounded shape. Huckell (1988) defined the Cienega type to describe a set of deeply corner-notched points with triangular blades in the Cienega Valley of southeastern Arizona. These types are distinguished primarily on the basis of notch morphology (depth, shape, and openness of notches), which allows for a wide range in overall point size. Date ranges for these types overlap, although San Pedro probably begins earlier (Mabry 1998; Sliva 1999). Mabry *et al.* (1997) place the San Pedro phase at 1200–800 B.C., with the Cienega phase spanning 800 B.C.–A.D. 150 in southern Arizona. Points consistent with these forms and date ranges have been recovered in the Big Burro Mountains of southwest New Mexico as well (Van Hoose 2000). Four US 54 points were classified as San Pedro (LA 6829, LA 115260, LA 128699, and LA 128708). One point between San Pedro and Cienega forms was recovered from LA 128709. Figure 21.1, D–I.

### Late Formative Types

With the advent of the bow and arrow, projectile points throughout the Southwest underwent a reduction in size. The following Late Formative forms were identified at US 54 sites.

**Fresno.** These small arrow points are triangular and unnotched, with straight or slightly convex edges and slightly convex bases (O'Hara 1988b:305). Dates for these reported in the literature range between A.D. 800–1750 (Dorshow *et al.* 2000:73) and A.D. 900–1800 (O'Hara 1988b:305). Both US 54 Fresno points were

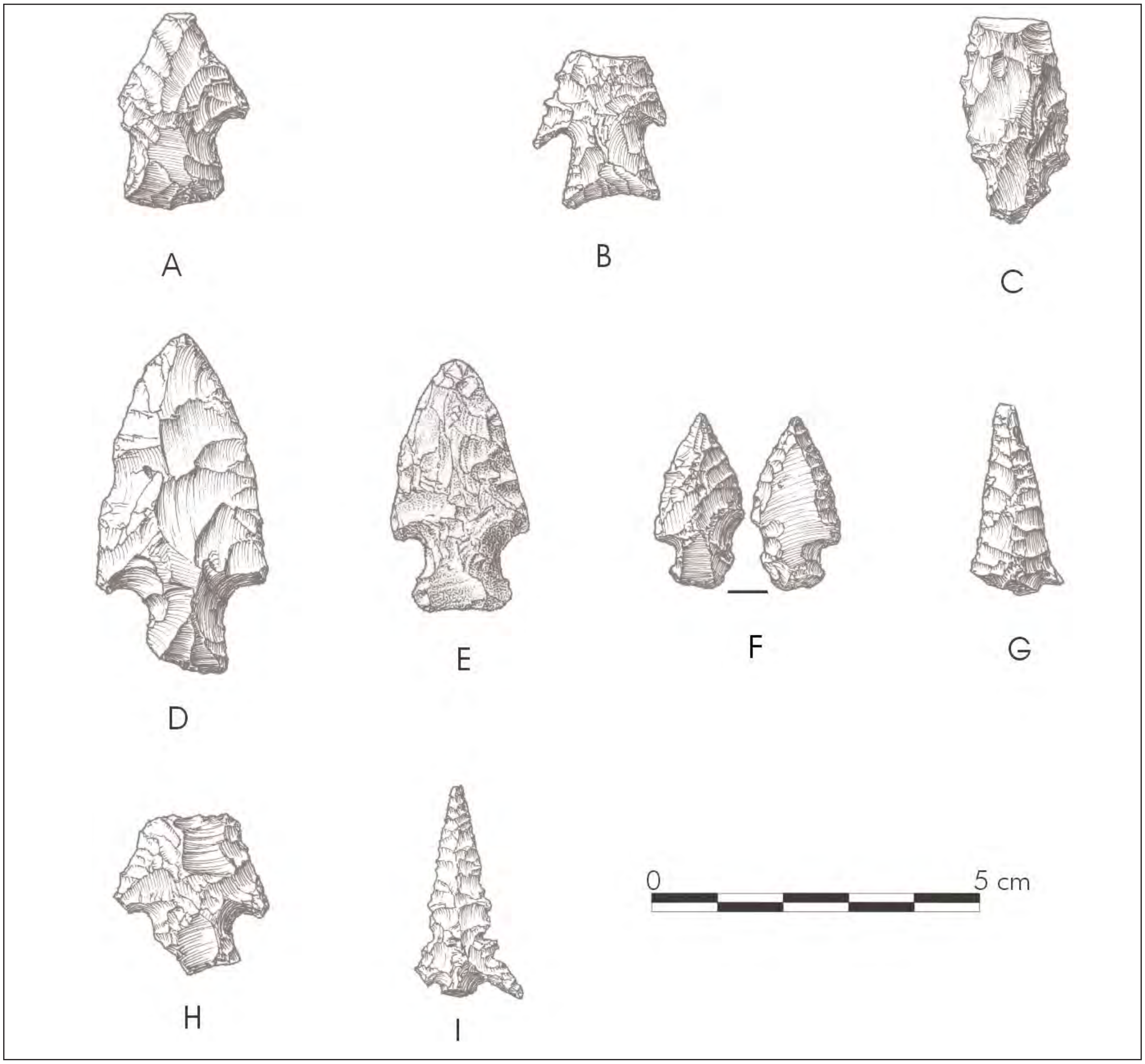


**Figure 21.1 Archaic/Early Formative Dart Point Types. A. Ellis (LA 6829, PNUM 508); B. possible Martindale (LA 115260, PNUM 230); C. Palmillas (LA 128700, PNUM 9); D–G. San Pedro (D: LA 6829, PNUM 1585; E: LA 115260, PNUM 233; F: LA 128699, PNUM 401; G: LA 128708, PNUM 3); H. San Pedro/Cienega (LA 128709, PNUM 6); I. Cienega (LA 115260, PNUM 146).**

recovered from LA 6829, a Formative site; one is made of Mount Taylor obsidian. Figure 21.2, A and B.

**Harrell.** Arrow points of this type are triangular, of similar shape to Fresno points, with straight to convex sides and relatively straight bases. Harrell points are notched as well, with sharp side notching often at the midpoint of the artifact or even further forward; these points also sometimes exhibit strong basal notches. The date range reported for Harrell points is A.D. 1100–1500 (Dorshow *et al.* 2000:73; O'Hara 1988b:306). Two Harrell points were



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recovered from LA 6829, one with a slightly convex base and the other with a basal notch (Figure 21.2, C and D).

**Scallorn.** Scallorn points are described as having triangular blades, slightly convex edges, with corner notching and occasional side notches, and a straight to concave base (O'Hara 1988b:305, 324). Date ranges for this type have been reported as A.D. 700–1500 (Dorshow *et al.* 2000:73) and A.D. 500–1200 (O'Hara 1988b:305), and the type occurs throughout New Mexico and Texas. A single Scallorn point was recovered from LA 115260, a Formative-period site (Figure 21.2, E).

### Unidentified Types

Two US 54 projectile points were not assigned cultural-historical types. One of these is a small notched flake with minimal retouch, the shape of which is insufficiently formal to assign to a type. This artifact, recovered from the Formative site LA 6829, is an elongated oval-shaped flake exhibiting weak side or corner notching and is of a size typical of arrow points (Figure 21.2, F). In addition, a point of dart size was recovered from the Formative site LA 115260. This artifact is fragmentary and heavily reworked, obscuring many elements of form.

### Correlation of Point Types with Temporal Contexts

All points identified as Late Formative types were recovered from contexts determined through radiocarbon dates and other criteria as Late Formative sites: LA 6829 and LA 115260. Late Archaic dart types appear in sites with Late Archaic contexts (LA 128699 and LA 128700), as well as those with mixed assemblages. Dart types also appear in the Late Formative sites LA 6829 and LA 115260. Date ranges for all of these point types are too wide to refine the chronological inferences based on radiocarbon dates and ceramics at these sites, but are generally consistent with them.

The presence of dart point types at LA 6829 and LA 115260 may be attributed to several reasons. The most likely options are that there are as yet unidentified Late Archaic components at these sites, or that the inhabitants of these sites may have scavenged points from Late Archaic contexts and reused them. Also possible is that large point forms continued to be manufactured after the introduction of the bow and arrow; Turnbow (1997:228) cites possible evidence for this elsewhere in the Southwest. However, without any specific evidence, this is merely an intriguing question.

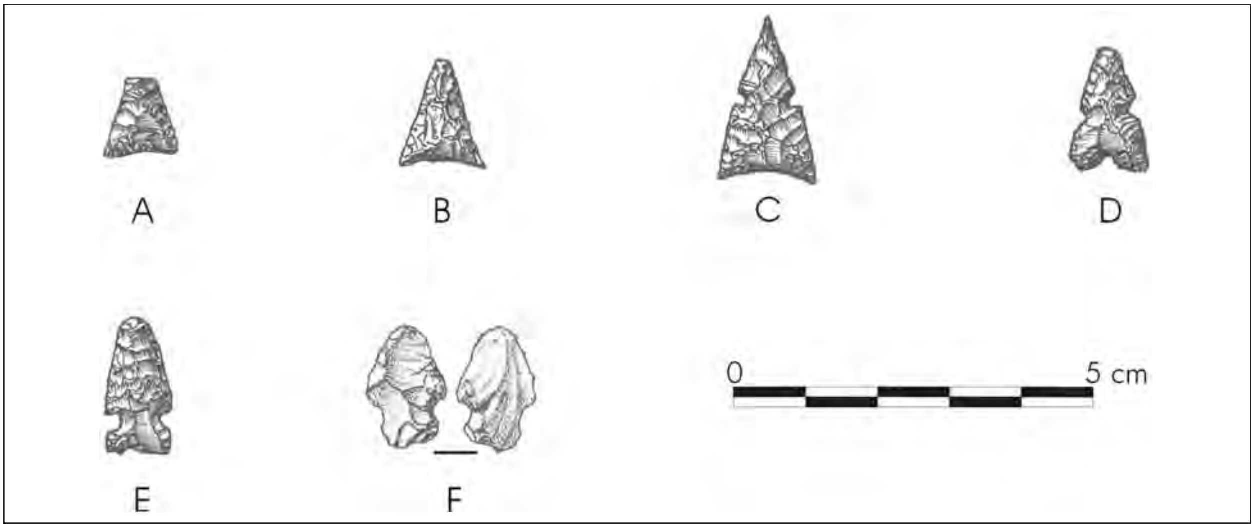


**Figure 21.2** **Late Formative Arrow Point Types. A and B. Fresno (A: LA 6829, PNUM 897; B: LA 6829, PNUM 1331); C and D. Harrell (C: LA 6829, PNUM 1787; D: LA 6829, PNUM 123); E. Scallorn (LA 115260, PNUM 154); F. notched flake (LA 6829, PNUM 1502).**

### Other Point Data

While notch angle measurements and maximum width position determinations were made for these points, the overall point sample is too small to render any statistically significant comparisons. All measurements taken on these 16 points are presented in Appendix D.

## ***Bifaces***

Bifaces are artifacts showing marked bifacial thinning or deep bifacial retouch. Using an idealized stage typology (adapted from Roxlau *et al.* 1997:61–70) as a starting point, we categorized all artifacts with systematic bifacial working into stages based on flaking patterns, intensity of reduction, and overall artifact form. This does not imply that all bifaces are on a standard trajectory from Stage I to Stage VI; it is simply a useful descriptive shorthand encompassing an overall description of form and reduction intensity. The stages are as follows:

- **Stage I**. Blank morphology is still evident on the piece; primary retouch has taken place but no thinning has occurred.
- **Stage II**: The artifact exhibits coarse flaking and the beginnings of thinning, obliterating most of the blank morphology
- **Stage III**: The biface shows regular margins and has undergone initial thinning, with none of the original blank form remaining
- **Stage IV**: Platform preparation and coarse thinning are apparent
- **Stage V**: The biface exhibits regular margins and some marginal retouch, with some pressure flaking possible
- **Stage VI**: Final shaping; the biface shows fine marginal retouch

In addition to assigning each biface to a reduction stage, variables monitored included material type, completeness, the type of use-wear (nibbling, rounding, polish, or none), evidence of heat alteration (altered luster, heat spalls, crazing, other, or none), and percent of artifact surface covered by cortex (less than 30 percent, 30–70 percent, greater than 70 percent, or absent). Calipers were used to measure all intact dimensions: length, width and thickness (all in millimeters) and weight were recorded in grams for all pieces using an electronic balance.

Fourteen nonprojectile bifaces were recovered from eight sites during US 54 investigations (Table 21.2), only five of which were complete or mostly complete. These embody the full range of biface reduction, from Stage I to Stage VI (Figure 21.3). Nonprojectile bifaces were quite rare, with the most found at any one site being three (LA 6829). It is therefore difficult to draw conclusions about trends in biface manufacture at the level of individual site, but patterns become evident when bifaces from the US 54 assemblages are combined.

The data in Table 21.3 indicate a relationship between time and bifacial reduction stage; the most thoroughly finished bifaces (Stages III and V) are associated with Archaic components, while most Formative-period bifaces are Stage I. Mixed assemblages include bifaces of Stages I, II, and IV, and the Historic biface is Stage II. The small sample here suggests a less formal biface technology associated with later occupations in contrast with highly finished and finely worked tools during the Archaic, a pattern to be expected based on our general understanding of the emphasis on chipped stone tool manufacture during the Archaic (Chapman 1977:447; Olszewski and Simmons 1982:113; Sullivan and Rozen 1985:766). Larger sample sizes might increase the significance of this association. Relevant to this discussion is the fact that all of the Stage V bifaces are fragmentary, one extremely so (LA 128700, PNUM 335), and none have extant basal or proximal portions. This raises the possibility that some or all may in fact be projectile points, but without intact hafting elements. In addition, the Stage VI biface is finely retouched along all margins but may be a heavily reworked point fragment. Its form is highly asymmetrical.

**Table 21.2 Individual Bifaces Collected from US 54 Sites, by Reduction Stage**

| Stage | Length (mm) | Width (mm) | Thickness (mm) | Weight (g) | Material | Completeness | Period | Site (LA) | PNUM |
|---|---|---|---|---|---|---|---|---|---|
| I | 50 | 40 | 17 | 33.3 | Silicified shale | Whole | Formative | 6829 | 587 |
| I | 73 | 52 | 25 | 83 | Rhyolite | Whole | Formative | 6829 | 437 |
| I | | 63 | 15 | 55.5 | Silicified shale | Half | Formative | 6829 | 1017 |
| I | | 47 | 26 | 68.9 | Limestone | Indeterminate small fragment | Mixed | 115262 | 120 |
| I | 75 | 39 | 20 | 58.2 | Rancheria chert | Whole | Unknown | 126178 | 6 |
| I | | | | 12 | Rancheria chert | Indeterminate small fragment | Unknown | 126178 | 4 |
| II | 59 | 57 | 12 | 45.6 | Chert | Mostly complete | Mixed | 128708 | 1 |
| II | | 24 | 8 | 4.5 | Historic glass | Medial fragment | Historic | 128709 | 5 |
| III | | | 6 | 1.2 | Chert | Distal fragment | Archaic | 128700 | 721 |
| IV | | 21 | 9 | 7.1 | Igneous | Distal fragment | Mixed | 128709 | 1 |
| V | | 12 | 4 | 0.9 | Chert | Distal fragment | Archaic | 128699 | 11 |
| V | | | | 0.3 | Chert | Lateral fragment | Archaic | 128700 | 335 |
| V | | 17 | 7 | 6 | Chert | Medial fragment | Formative | 115260 | 309 |
| VI | 15 | 9 | 3 | 0.4 | Chert | Mostly complete | Formative | 115260 | 160 |

**Table 21.3 Biface Reduction Stage by Period**

| General Period | Stage I | Stage II | Stage III | Stage IV | Stage V | Total |
|---|---|---|---|---|---|---|
| Archaic | | | 1 | | 2 | *3* |
| Mixed | 1 | 1 | | 1 | | *3* |
| Formative | 3 | | | | 1 | *4* |
| Historic | | 1 | | | | *1* |
| *Total* | *4* | *2* | *1* | *1* | *3* | *11* |

In addition to a trend from finer bifaces to less-thoroughly reduced bifaces, this small sample also follows the expected pattern of decreasing material quality through time noted by Carmichael (1986) and others. Table 21.4 shows that all three Archaic bifaces are chert, while most Formative bifaces are silicified shale or rhyolite. This reflects the same pattern seen in a recent study of Late Archaic and Late Pit House period sites along NM Highway 90 in the Big Burro Mountains to the west, involving the large Late Archaic Wood Canyon site (LA 99631; Van Hoose 2000). Wood Canyon bifaces tended to be of higher-quality materials such as chert and were predominantly advanced, highly finished bifaces in contrast to the later sites (Van Hoose 2000:374–375).

### Tool Use

One Stage I biface from LA 128709, a temporally mixed assemblage, is retouched unifacially at one end and as such resembles a scraper. It is possible that this unifacial modification was secondary to the biface's original purpose. No edge wear was identified on this piece.

Four bifaces show edge modification consistent with use-wear (Table 21.5). These are from sites LA 115260, LA 115262, LA 128708, and LA 128709. This includes one Stage I, two Stage II, and one Stage V biface. None of the bifaces with use-wear are from Archaic-only contexts.

## ***Retouched Tools***

Retouched tools are defined here as artifacts showing definite, continuous retouch and/or thin-

**Table 21.4 Biface Materials by Period (Artifacts of Known Temporal Affiliation Only)**

| General Period | Chert | Igneous | Limestone | Rhyolite | Silicified shale | Historic glass | Total |
|---|---|---|---|---|---|---|---|
| Archaic | 3 | | | | | | 3 |
| Mixed | 1 | 1 | 1 | | | | 3 |
| Formative | 1 | | | 1 | 2 | | 4 |
| Historic | | | | | | 1 | 1 |
| *Total* | *5* | *1* | *1* | *1* | *2* | *1* | *11* |



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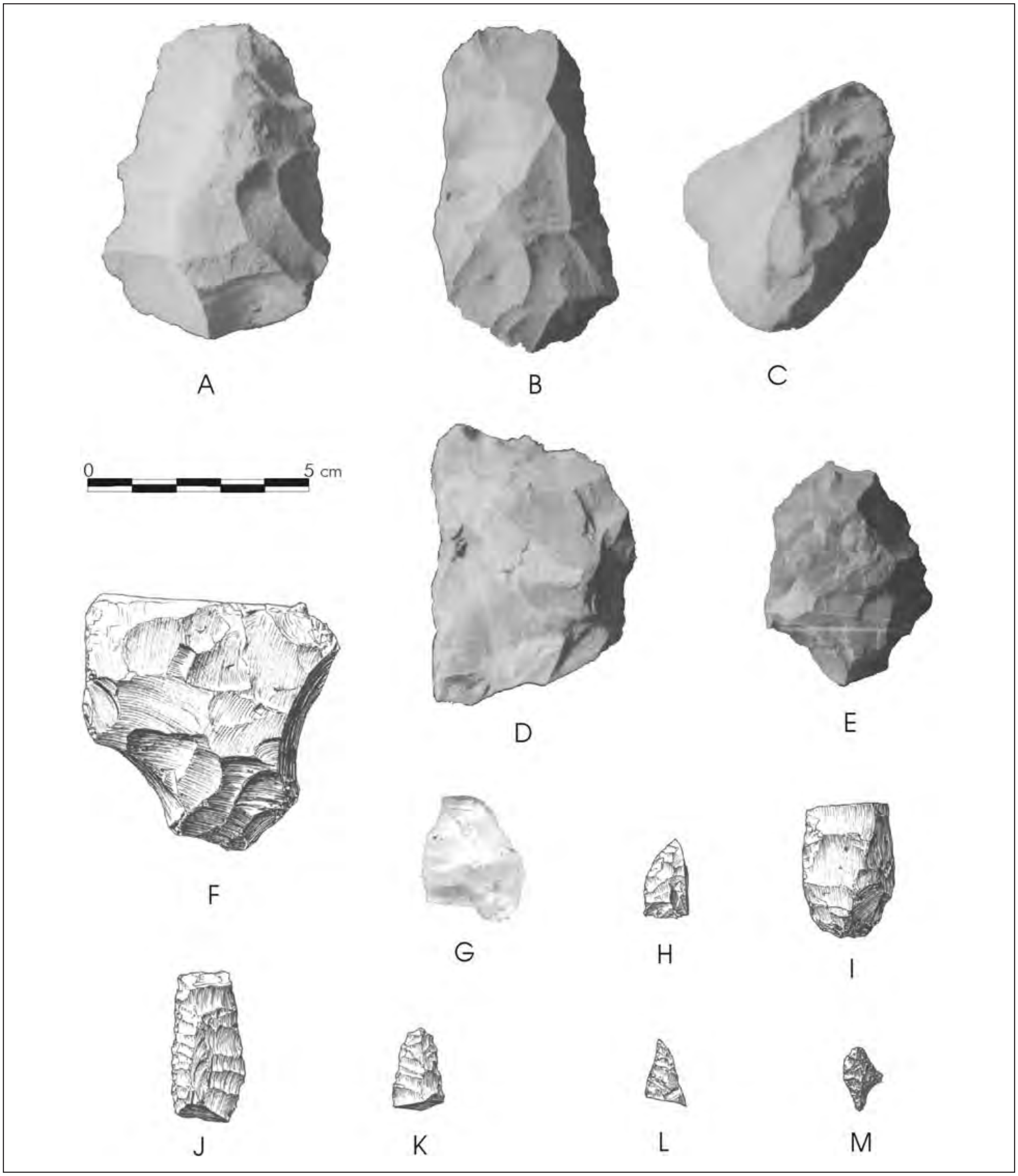


**Figure 21.3 Bifaces. A–E. Stage I (A: LA 6829, PNUM 437; B: LA 126178, PNUM 6; C: LA 115262, PNUM 120; D: LA 6829, PNUM 1017; E: LA 6829, PNUM 587); F and G, Stage II (F: LA 128708, PNUM 1; G: LA 128709, PNUM 5); H. Stage III (LA 128700, PNUM 721); I. Stage IV (LA 128709, PNUM 1); J–L. Stage V (J: LA 115260, PNUM 309; K: LA 128699, PNUM 11; L: LA 128700, PNUM 335); M. Stage VI (LA 115260, PNUM 160).**



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**Table 21.5 Edge Modification by Biface Reduction Stage**

| Edge Modification | Stage I | Stage II | Stage III | Stage IV | Stage V | Total |
|---|---|---|---|---|---|---|
| None | 5 | | 1 | 1 | 2 | 9 |
| Nibbling | | 1 | | | 1 | 2 |
| Rounding | 1 | 1 | | | | 2 |
| Total | 6 | 2 | 1 | 1 | 3 | 13 |

ning, but which did not qualify as either projectile points or bifaces (Figure 21.4). Retouched tools include any tool made through the intentional, continuous application of retouch to form one or more working edges. Bifaces—tools thinned bifacially—are treated separately in this analysis. Tools with minimal or shallow bifacial retouch, but which are not systematically reduced bifacially, are considered to be retouched tools. Retouched tools are broadly divided into six primary types defined as follows:

- **Scrapers.** These are pieces of stone (usually flakes) that have been retouched continuously along one or more margins, producing a steep edge angle. Retouch is always primarily unifacial. Pieces exhibiting highly formalized facial retouch were noted, but the vast majority of scraping tools analyzed here were much more expedient flake tools. Scrapers were recorded according to the number and configuration of working edges relative to the original flake:

    - **Side Scraper, single edge.** These tools were retouched continuously along only one lateral flake margin.

    - **Side Scraper, double edge.** These tools were retouched continuously along two lateral margins, but not on the distal margin.

    - **Scraper, three edges.** These tools were retouched continuously along both lateral margins and the distal margin, leaving the original platform portion of the flake unmodified.

    - **Scraper, ovoid.** These tools are retouched continuously on all margins and the platform area, creating a tool without non-retouched edges.

    - **Scraper, miscellaneous.** This category was used when the tool was too fragmentary to reliably estimate the original extent of retouch.

- **Projection.** Projections are tools that exhibit pronounced points or protrusions created by retouch. These usually are formed by notching and/or deep repetitive retouch at either side of the intended projection, creating a roughly triangular protrusion. These may be interpreted as gravers or perforators (cf. Huckell 1995:58), but their intended use is unclear. These tools may have continuous marginal or facial retouch as well, suggesting possible additional use as scrapers.

- **Chopper.** Choppers are large flakes or stone pieces that are retouched along a single margin, often bifacially, that show subsequent battering along the edge formed by the intersection of flake scars. Choppers examined in this section appear to have been systematically formed for use as tools, usually by removing flakes that are probably too small to have been further modified for independent use. This distinguishes them from bi-directional cores that had secondary or additional use for chopping activities, which are discussed in the section on core tools.

- **Digging tool.** These are large pieces of stone, usually tabular, that show retouch and/or battering along an edge. These were judged not to be scrapers, but are hypothesized to be digging tools. Only two of these were recovered, one from LA 115259 and another from 115262.

- **Tabular knife.** Only one specimen of this tool type was found. It is a tabular piece of indurated limestone with a trapezoidal cross-section. The artifact shows discontinuous unifacial retouch along two parallel working edges, which exhibit some rounding wear. While the retouch configuration might have placed it in the "scraper" category, its morphology was sufficiently distinct to warrant a separate type designation.

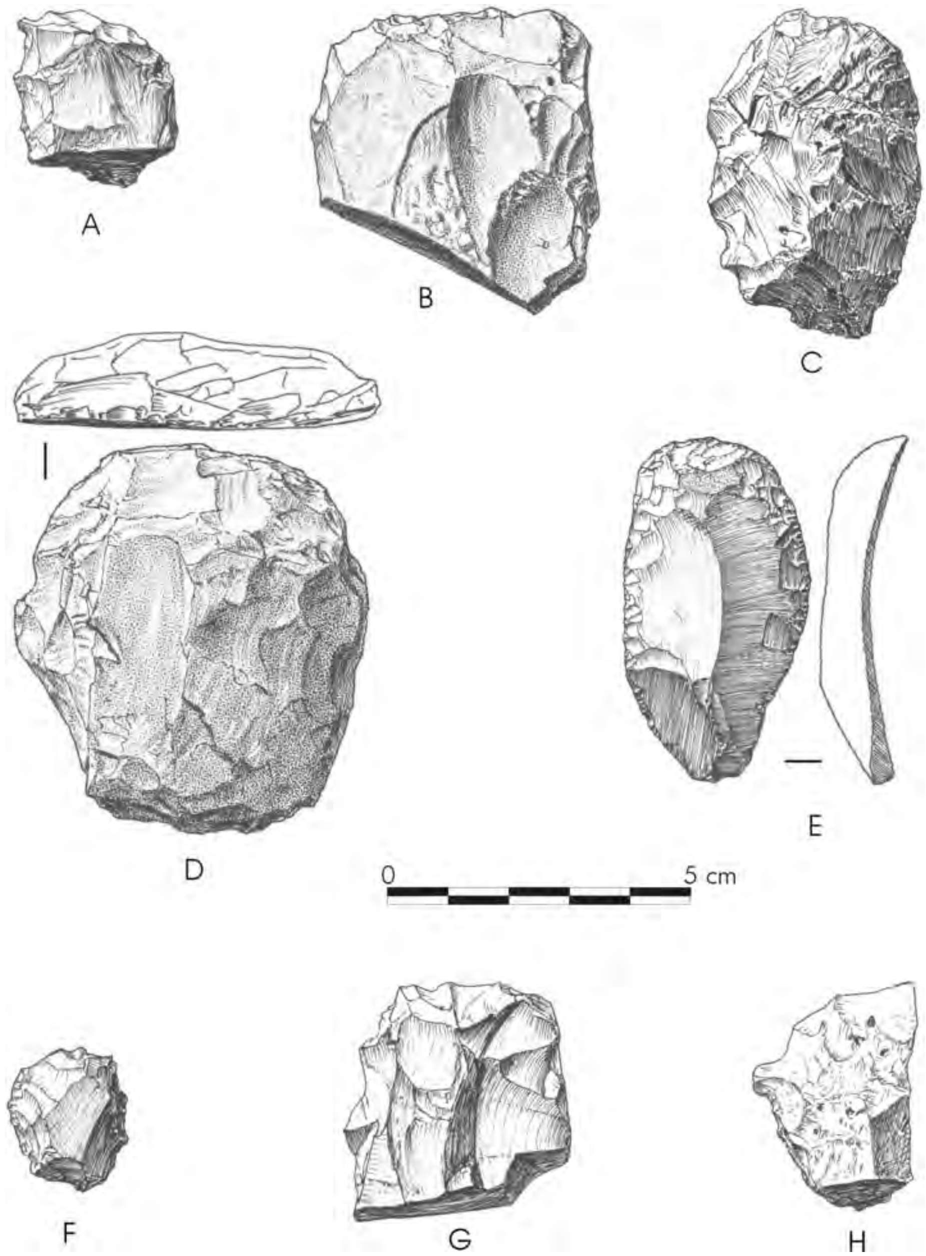


**Figure 21.4** **Retouched tools. A. miscellaneous scraper (LA 128700, PNUM 72); B. double-edge scraper (LA 115262, PNUM 88); C. three-edge scraper (LA 115262, PNUM 57); D–F. ovoid scrapers (D: LA 115260, PNUM 305; E: LA 115262, PNUM 52; F: LA 128699, PNUM 61); G. retouched piece (LA 115262, PNUM 131); H. projection (LA 128699, PNUM 219).**



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**Retouched piece, miscellaneous.** This is a catch-all category for pieces that exhibit intentional retouch, but either do not have retouch over a long, contiguous margin, or show only weak or shallow marginal retouch. These are considered more expedient, less formal tools than the other categories listed here, and constitute the most common retouched tool type in this study.

In addition to these type assignments, the following variables were recorded in this analysis: material, evidence for heat modification (altered luster, heat spalls, crazing, other, absent), percent cortex cover (less than 30 percent, 30–70 percent, greater than 70 percent, or absent), completeness (broken, whole), retouch surface (which flake surface exhibits flake scars from retouch: interior, exterior, both, or fracture surface), edge modification (type of edge modification in addition to retouch, e.g., edge wear: nibbling, rounding, polish, none), number of bits (for projections only), and retouch type (continuous, discontinuous). Calipers were used to measure all intact dimensions: length, width and thickness (all in millimeters) and weight was recorded in grams for all pieces using an electronic balance.

One-hundred-ten retouched tools were analyzed from US 54 sites (Table 21.6). Most of these are scrapers (n=48), followed by miscellaneous retouched pieces (n=47).

While there is a slightly higher representation of scrapers during the Archaic than during the Formative (Table 21.7), suggesting possible greater formality to retouched tools during this time, the overall distribution of general artifact types shows no significant difference ($\chi^2$=2.391, significance level=0.793). Further, there were no statistical differences between periods in the relative representation of different scraper subtypes, in the size of flakes used for retouched tools, or in the proportional representation of continuous versus discontinuous retouch. This suggests that the same general patterns of relatively expedient tool manufacture and use persist throughout this time span. Summary statistics for retouched tools for the Archaic and Formative periods are presented in Table 21.8.

This temporal continuity does not extend to raw material exploitation, however. Following the pattern observed in nearly every artifact class, Table 21.9 shows that Archaic assemblages are

**Table 21.6 Retouched Tool Types Recovered from US 54 Sites**

| Tool Type | 6829 | 115255 | 115256 | 115259 | 115260 | 115262 | 115265 | 126178 | 126181 | 128699 | 128700 | 128708 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chopper | 1 | 1 | | | 1 | 1 | | | | 2 | | | 6 |
| Digging tool | | | | 1 | | 1 | | | | | | | 2 |
| Projection | 1 | | | | | 1 | | | | 1 | 3 | | 6 |
| Retouched piece, miscellaneous | 13 | | 1 | | 3 | 9 | 1 | 1 | 1 | 9 | 9 | | 47 |
| Side scraper, single edge | 2 | 1 | 1 | 1 | | 2 | | | | 2 | 5 | | 14 |
| Side scraper, double edge | 1 | | | 1 | | 1 | | 1 | | 2 | 3 | | 9 |
| Scraper, three edges | | | | | 1 | 1 | | | | 1 | 2 | 2 | 7 |
| Scraper, miscellaneous | 1 | 1 | | | 6 | 1 | 1 | | | 2 | 3 | | 15 |
| Scraper, ovoid | | | | | 1 | 1 | | | | 1 | | | 3 |
| Tabular knife | 1 | | | | | | | | | | | | 1 |
| *Total* | *20* | *3* | *2* | *3* | *12* | *18* | *2* | *2* | *1* | *20* | *25* | *2* | *110* |



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**Table 21.7 General Retouched Tool Types, by Period**

| Lumped tool type | Archaic | Mixed | Formative/Mixed | Formative | Unknown | Total |
|---|---|---|---|---|---|---|
| Chopper | 1 | 1 | 1 | 2 | 1 | *6* |
| Digging tool | | 1 | | 1 | | *2* |
| Projection | 2 | 1 | 2 | 1 | | *6* |
| Retouched piece | 11 | 9 | 7 | 18 | 2 | *47* |
| Scraper | 11 | 8 | 10 | 15 | 4 | *48* |
| Tabular knife | | | | 1 | | *1* |
| *Total* | *25* | *20* | *20* | *38* | *7* | *110* |

dominated by cherts (72 percent), while Formative assemblages are only 21 percent chert. Silicified shale constitutes 55 percent of Formative assemblages but only eight percent of Archaic.

## ***Cores and Core Tools***

Cores are stones from which flakes have been intentionally removed. Because the manufacture of lithic tools also involves removal of flakes from a stone nucleus, the line between cores and tools can be indistinct. For the purposes of this analysis, cores include all nondebitage artifacts that show systematic removal of flakes large enough to be subject to further modification (shaped into a projectile point, for instance), or to be used as expedient tools. This also includes rocks with only one or two flake scars representing flakes large enough to be of further use ("tested pieces"). In other words, reduced nuclei that obviously began as flakes were classified as tools, while stones—often cobbles or blocky pieces—with evidence of flake removal were identified as cores. Because this does not preclude cores from

**Table 21.8 Summary Statistics for Dimensions and Weight of Retouched Tools, by Period**

| | Archaic | | | | Formative | | | |
|---|---|---|---|---|---|---|---|---|
| | **Minimum** | **Maximum** | **Mean** | **Std. Deviation** | **Minimum** | **Maximum** | **Mean** | **Std. Deviation** |
| **Length (mm)** | 15 | 137 | 47.5 | 30.2 | 13 | 142 | 46.5 | 28.3 |
| **Width (mm)** | 10 | 104 | 35.4 | 24.2 | 7 | 88 | 31.8 | 16.7 |
| **Thickness (mm)** | 4 | 42 | 15.1 | 9 | 3 | 33 | 13.7 | 8.1 |
| **Weight (g)** | 0.7 | 572.8 | 64.8 | 139.1 | 0.3 | 362.7 | 40.8 | 71 |

**Table 21.9 Materials Represented in Retouched Tool Assemblages**

| Materials | Archaic | Formative | Formative/Mixed | Mixed | Unknown | Total |
|---|---|---|---|---|---|---|
| Chert | 18 | 7 | 10 | 7 | 2 | *44* |
| Granite | | 1 | 1 | 1 | | *3* |
| Igneous | 1 | | 1 | | | *2* |
| Limestone | 1 | 5 | | 4 | | *10* |
| Obsidian | 1 | | | | | *1* |
| Quartzite | | | | 3 | | *3* |
| Rhyolite | 2 | | 3 | 2 | | *7* |
| Rancheria chert | | 1 | | | 3 | *4* |
| Sandstone | | 3 | 1 | | 1 | *5* |
| Silicified shale | 2 | 21 | 4 | 3 | 1 | *31* |
| *Total* | *25* | *38* | *20* | *20* | *7* | *110* |

being used as tools, indicators of post-reduction use, such as edge wear or battering, also were identified and recorded.

The following attributes were recorded for cores: material, tool type (chopper, scraper, hammerstone), evidence of heat modification (altered luster, heat spalls, crazing, other, absent), battering configuration (if also used as a hammerstone; see following section for further discussion of this variable), percent cortex cover (less than 30 percent, 30–70 percent, greater than 70 percent, or absent), and number of flake scars. Length, width, and thickness were measured to the nearest millimeter using calipers, and weight was recorded to the nearest tenth of a gram using an electronic balance. In addition, *core directionality* was recorded, referring to the number of platforms from which flake scars originate and their orientation to each other. Options include *unidirectional* (showing scars oriented in a single direction), *bi-directional* (scars oriented in two directions, usually originating at a bifacial edge), and *multidirectional* (scars oriented in three or more directions).

Sixty-five cores were recovered from US 54 sites. These are dominated by silicified shale (n=36) and cherts (n=10), followed by numerous additional materials (Table 21.10). Three of the objects included here as "limestone cores" are in fact highly weathered pieces of limestone that have overall shapes consistent with cores, but on which flake scars are indistinct (Figure 21.5). Two of these weathered cores are from LA 128699 and the other is from LA 128700. Table 21.11 shows core material types by general time period, and again shows the clear difference in material types between the Archaic and Formative assemblages. Chert represents 30 percent (n=5) of the Archaic core assemblages but only six percent (n=2) of the Formative cores, while silicified shale accounts for 79 percent (n=27) of the Formative cores and only 27 (n=4) percent of the Archaic. A chi-square test shows these material differences to be statistically significant ($\chi^2$=44.305, significance=.007).

Table 21.12 presents core directionality data for all cores according to time period. There is a slightly higher proportion of multidirectional cores at Formative components (n=21, 62 percent) than at Archaic (n=7, 47 percent). This difference is not statistically significant, however ($\chi^2$=1.083, significance level=.582) at this sample size. Multidirectional cores are associated with expedient, opportunistic reduction, and are the dominant type seen throughout Formative sites in the region (Whalen 1994b:101; Graves and Miller 2001:219; Miller 1990:138). In contrast, the Wood Canyon site in southwest New Mexico (Van Hoose 2000), a Late Archaic site with chipped stone technology very similar to that found at the US 54 Late Archaic components for which comparable data are available (see debitage section below), shows a marked predominance of unidirectional cores contrasted with greater numbers of multidirectional cores in later sites in the region (Van Hoose 2000:387).

As shown in Table 21.13, cores from Archaic and Formative assemblages are very similar in terms of length, width, and thickness, as well as average scar counts. Average weights do differ, with

**Table 21.10 Cores Recovered from US 54 Sites, by Material**

| Materials | 6829 | 115257 | 115260 | 115262 | 126181 | 128699 | 128700 | 128708 | Total |
|---|---|---|---|---|---|---|---|---|---|
| Chert | 2 | | | 1 | | 1 | 6 | | 10 |
| Igneous | 2 | | | | | | | | 2 |
| Limestone | 2 | | | 3 | | 2 | 2 | | 9 |
| Quartzite | 1 | | | | | | 1 | | 2 |
| Rhyolite | | | | | | | 3 | | 3 |
| Rancheria chert | | | | | | 3 | | | 3 |
| Silicified shale | 17 | 1 | 8 | | 2 | 4 | 2 | 2 | 36 |
| *Total* | *24* | *1* | *8* | *4* | *2* | *10* | *14* | *2* | *65* |



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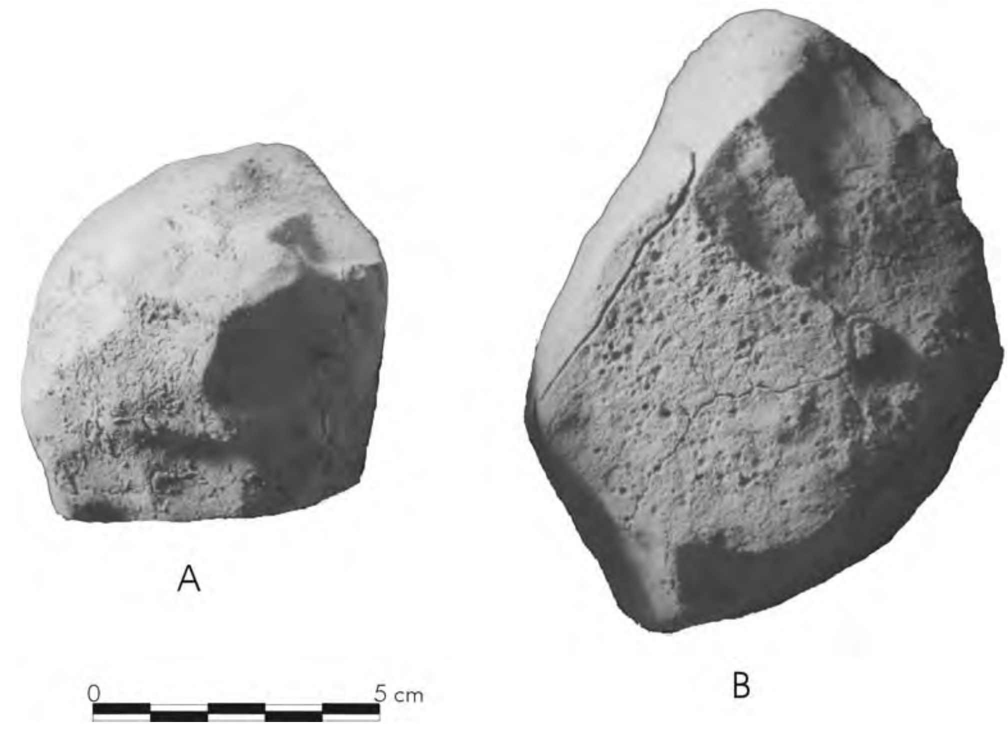


**Figure 21.5 Weathered limestone cores from LA 128699 (A. PNUM 218; B. PNUM 184).**

**Table 21.11 Core Material Types, by Period**

| Materials | Archaic | Formative Mixed | Mixed | Formative | Unknown | Total |
|---|---|---|---|---|---|---|
| Chert | 5 | 2 | 1 | 2 | | 10 |
| Igneous | | | | 2 | | 2 |
| Limestone | 2 | 2 | 3 | 2 | | 9 |
| Quartzite | | 1 | | 1 | | 2 |
| Rhyolite | 1 | 2 | | | | 3 |
| Rancheria chert | 3 | | | | | 3 |
| Silicified shale | 4 | 2 | 2 | 27 | 1 | 36 |
| *Total* | *15* | *9* | *6* | *34* | *1* | *65* |

**Table 21.12 Core Directionality, by Period**

| Period | Unidirectional | Bidirectional | Multidirectional | Unknown | Total |
|---|---|---|---|---|---|
| Archaic | 3 | 4 | 7 | 1 | 15 |
| Formative/Mixed | 4 | 3 | 1 | 1 | 9 |
| Mixed | 1 | 1 | 4 | | 6 |
| Formative | 4 | 7 | 21 | 2 | 34 |
| Unknown | 1 | | | | 1 |
| *Total* | *13* | *15* | *33* | *4* | *65* |



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Archaic cores having a lower average weight than Formative cores, but standard deviations are large. Whalen (1994b:98) cites data from a project in the White Sands area showing Archaic cores to be smaller than Formative cores. However, the mean weights given (33 grams for Archaic, 71 grams for Formative) are smaller than those presented here.

**Core Tools**

Several cores also show use-wear and/or additional modification that indicate use as tools. These are shown in Table 21.14; for tool type definitions, see the sections on retouched tools and hammerstones in this chapter. One Archaic core and three Formative cores were used as choppers, while one Formative core was morphologically similar to a scraper and showed use-wear consistent with this purpose. In addition, five Formative cores and three cores from mixed contexts were used as hammerstones. Two cores, one Archaic and one from a Formative/Mixed context, showed some use-wear but were not able to be assigned to specific tool categories.

The cores used as hammerstones showed battering wear consistent with percussion against hard surfaces such as rock. All but one of these cores showed longitudinal battering patterns, with one Formative core showing localized battering on a single protuberance. See the section on hammerstones for further discussion of these battering patterns.

## *Hammerstones*

Hammerstones are defined as rocks, usually with little or no evidence of systematic tool modification, that show pronounced evidence of battering due to percussion. This is often the result of use as a hammer during flintknapping, but may also encompass additional hammering tasks (Figure 21.6).

Variables recorded for these artifacts include material type, weight (measured to the nearest tenth of a gram using an electronic balance), and length, width, and thickness (measured using a caliper to the nearest millimeter). In addition to these, *battering configuration* was noted. This describes the location and amount of battering present on the artifact, and includes the following options:

- **Single protuberance:** Battering is localized to a single relatively small area on the rock.
- **Polar:** Battering is present on two opposite ends of an oblong rock.

**Table 21.13 Summary Statistics for Core Data, Including Scar Count**

| | Archaic | | | | Formative | | | |
|---|---|---|---|---|---|---|---|---|
| | Minimum | Maximum | Mean | Std. Deviation | Minimum | Maximum | Mean | Std. Deviation |
| **Length (mm)** | 24 | 76 | 49 | 16.2 | 29 | 115 | 54.8 | 19 |
| **Width (mm)** | 22 | 65 | 41.2 | 14.4 | 19 | 83 | 42.8 | 13.8 |
| **Thickness (mm)** | 14 | 56 | 27.9 | 11.1 | 14 | 42 | 27.4 | 7.2 |
| **Weight (g)** | 12.7 | 297.6 | 76.7 | 79.4 | 10.3 | 511.8 | 95.5 | 117.2 |
| **Scar count** | 2 | 14 | 5.7 | 3.3 | 2 | 10 | 5.3 | 2 |

**Table 21.14 Core Tool Types, by Period**

| Period | Chopper | Hammerstone | Scraper | Other | No tool use | Total |
|---|---|---|---|---|---|---|
| Archaic | 1 | | | 1 | 13 | *15* |
| Formative | 3 | 5 | 1 | | 25 | *34* |
| Formative/Mixed | | | | 1 | 8 | *9* |
| Mixed | | 3 | | | 3 | *6* |
| Unknown | | | | | 1 | *1* |
| *Total* | *4* | *8* | *1* | *2* | *50* | *65* |



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**Figure 21.6 Silicified shale hammerstone from LA 6829 (PNUM 1348), with longitudinal battering and slight polish on one face.**

- **Longitudinal:** Battering is found around the entire circumference or perimeter of a rock, but lies mostly in a single plane.
- **Generalized:** Battering covers much of the rock, with little preferential localization.

Twenty-three hammerstones were identified in the US 54 assemblages. These are dominated by silicified shale, followed by quartzite and various other materials (Table 21.15). With the exception of a single limestone hammerstone, all of these rock types are quite hard and durable and well suited to hammering.

No hammerstones were recovered from Archaic contexts; all were from Formative or mixed assemblages, or from sites of unknown temporal affiliation. Most of the hammerstones (n=17) were recovered from LA 6829, which is the site with the largest chipped stone assemblage; silicified shale is also the most common debitage material at this site. At Formative site LA 6829, most of the hammerstones show longitudinal battering (n=9), followed by generalized battering (n=5), with the remaining three showing polar battering.

As noted in the section describing cores and core tools, eight cores also showed secondary use as hammerstones. Three of these are from LA 6829 and include two cores with longitudinal battering and one with battering on a single protuberance. In addition, two cores from LA 115269 and three cores from LA 115262 show longitudinal battering.

## *Debitage*

Debitage is defined here as the smaller products of knapping activities, which may or may not be subject to further modification: flakes and angular debris. A total of 5,580 pieces of lithic debitage was analyzed from the 14 components containing lithic debitage in the study area (Table 21.16). As discussed in Chapters 14 and 15 and below, it was determined that sites LA 128699 and 128700 each could be divided into two components, one Archaic and one Formative, based on the spatial organization of artifacts and radiocarbon dates. Of the 5,580 pieces of lithic debitage, 4,829 have a subsurface context, while the remaining 749 were collected from site surfaces. Assemblage

**Table 21.15 Materials Represented in Hammerstone Assemblages**

| Materials | 6829 | 115256 | 115260 | 115262 | 128708 | Total |
|---|---|---|---|---|---|---|
| Chert | 1 | | | 1 | | 2 |
| Granite | 2 | | | | | 2 |
| Igneous | 1 | | | | | 1 |
| Limestone | 1 | | 1 | | | 2 |
| Quartzite | 3 | 1 | | | | 4 |
| Rhyolite | | | | | 1 | 1 |
| Silicified shale | 9 | | 1 | | 1 | 11 |
| *Total* | *17* | *1* | *2* | *1* | *2* | *23* |

size was arbitrarily divided into large (more than 1,000 flakes), medium (100–1000 flakes) and small (fewer than 100 flakes). Radiocarbon dates and diagnostic artifacts provide the basis for cultural affiliation, which includes the following components: Archaic (2500 B.C.–A.D. 250), Formative (A.D. 250–1425), mixed (lithic components sharing both Archaic and Formative-period materials), and unknown (not enough information available). In this study there are two large Formative-period sites (LA 6829 and LA 115260), two medium Archaic period components (LA 128699A and LA 128700A), two medium mixed components (LA 128699P and LA 128700P), one medium mixed site (LA 115262), three small Formative-period sites (LA 115259, LA 115265, and LA 126181), one small mixed site (LA 128708), and five small unknown sites (LA 115255, LA 115256, LA 115257, LA 115263, and LA 126178).

### Sampling Strategy

Chapter 5 describes the excavation and collection strategy at each site. In general, surface artifacts were collected from the entire site surface and subsurface artifacts were collected after screening (using a 1/8-inch screen) in controlled 10-cm excavation units. In terms of the debitage analysis, 100 percent of all artifacts were analyzed from both surface and subsurface contexts with the exception of site LA 6829, a large Formative-period site. For LA 6829, a 50 percent sample, or 2,321 pieces, of debitage was analyzed; see the "Analytical Methods" section above for more information. LA 6829 was divided into three contexts (within features, surface contexts, and subsurface contexts) and from each context a 50 percent random sample of bag numbers was generated. From these bags, 100 percent of all artifacts were analyzed.

### Variables Analyzed in Debitage Analysis

Sullivan and Rozen's (1985) completeness method of debitage analysis was used as a starting point for this study. This method is based on flake completeness and uses a binary hierarchical decision tree to assign debitage types. With this decision tree, flakes are assigned to one of four mutually exclusive categories. These categories are determined based on three dimensions of flake variability: (1) single interior surface (SIS); (2) point of applied force; and (3) margins. Each

**Table 21.16 Site Characteristics of Sites Containing Lithic Artifacts**

| Site (LA) | Surface Debitage Count | Subsurface Debitage Count | Total Debitage Count | Assemblage Size | Cultural Affiliation |
|---|---|---|---|---|---|
| 6829 | 216 | 2105 | 2321 | Large | Formative |
| 115255 | 7 | 6 | 13 | Small | Unknown |
| 115256 | 2 | 2 | 4 | Small | Unknown |
| 115257 | 7 | 0 | 7 | Small | Unknown |
| 115259 | 2 | 2 | 4 | Small | Formative |
| 115260 | 22 | 1737 | 1759 | Large | Formative |
| 115262 | 5 | 150 | 155 | Medium | Mixed |
| 115263 | 0 | 1 | 1 | Small | Unknown |
| 115265 | 5 | 25 | 30 | Small | Formative |
| 126178 | 7 | 0 | 7 | Small | Unknown |
| 126181 | 19 | 3 | 22 | Small | Formative |
| 128699P | 8 | 150 | 158 | Medium | Mixed |
| 128699A | 187 | 390 | 577 | Medium | Late Archaic |
| 128700P | 77 | 52 | 129 | Medium | Mixed |
| 128700A | 167 | 170 | 337 | Medium | Late Archaic |
| 128701 | 0 | 6 | 6 | Small | Mixed |
| 128709 | 0 | 0 | 0 | Small | Mixed |
| 128708 | 15 | 32 | 47 | Small | Mixed |
| Total | 749 | 4831 | 5580 | | |



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flake is first examined to see if it has a single interior surface, which is characterized by a single bulb of percussion or ripple marks. If a flake does not have a SIS, it is categorized as debris. All flakes with a discernable SIS are then examined for the presence of a point of applied force, which occurs where the bulb of percussion intersects the striking platform. Both the bulb of percussion and the striking platform must be present for the flake to be classified as having a point of applied force. If a flake does not have a point of applied force, it can be classified as a flake fragment. Finally, flakes with both a single interior surface and a point of applied force are examined for presence or absence of intact margins. Intact margins exist when the original width and length of the flake can be reasonably determined. Broken flakes do not have intact margins, while complete flakes do. This simple method has the advantage of being replicable because it is based on mutually exclusive flake categories.

Potential problems exist with the Sullivan and Rozen system, as discussed by Amick and Mauldin (1989, 1997), Ensor and Roemer (1989), and, more recently, Prentiss (1998). All of the researchers agree that the advantage behind Sullivan and Rozen's system lies in its replicability in assigning flake completeness between different observers. The main problem with the Sullivan and Rozen system is that by itself flake completeness does not have inherent behavioral meaning, and is greatly affected by other variables such as material type. In an attempt to formally test the relationship between flake completeness and behavioral activity Prentiss (1998) created different artifacts using obsidian nodules, and found that the activities that Sullivan and Rozen suggest for their study did not correspond well to his experimental study. One potential problem of this critique is Prentiss's use of obsidian as the only material type to test the Sullivan and Rozen system. Obsidian is fragile and its flakes will often break more readily than those of stronger sedimentary rocks (i.e., chert) or the durable igneous rocks (i.e., rhyolite and basalt) (see Amick and Mauldin 1997). Sullivan and Rozen, in fact, based their study on assemblages comprised largely of chert, rather than obsidian. Thus Prentiss's critique of Sullivan and Rozen inadvertently underscored the differences in flake breakage rates in different material types and introduces a caveat into the use of their method when materials other than chert are involved. The US 54 assemblages contain a high frequency of silicified shale, a brittle lithic material, and thus Sullivan and Rozen's technique was employed here with an appropriate measure of caution.

Despite the potential problems with the Sullivan and Rozen system, it remains one of the best methods for characterizing debitage assemblages, especially when the main material exploited is durable. It offers the advantage of individually examining every piece of debitage, versus the quicker mass analysis system proposed by Ahler (1989). Other methods include a middle-range approach championed by Amick and Mauldin, but this also has problems (see Rozen and Sullivan 1989). As previously noted, Sullivan and Rozen's technique offers controls for interobserver error with its mutually exclusive flake categories, given proper training and consistency in the identification of key attributes (such as point of applied force and margins).

As noted above, flake completeness is highly conditioned by material type, with stronger materials such as chert and rhyolite yielding higher proportions of complete flakes as opposed to more brittle materials such as obsidian and silicified shale (Amick and Mauldin 1997; Lundquist 2002). Because silicified shale was the dominant material in the US 54 assemblages (68 percent of all debitage), this is deemed a potentially significant source of error. Based on Sullivan and Rozen's analysis, a high flake fragment percentage is more frequently associated with tool production/biface reduction than with core reduction. This makes intuitive sense, as biface production produces thinner flakes that are more likely to break during production than thicker core-reduction flakes. For this reason, *interpretations* based on Sullivan and



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Rozen's (1985) findings were not extensively used in this analysis, and it is recommended that it not be used to interpret behavior except when durable materials (such as chert and rhyolite) are involved (e.g., Lundquist 2002), and until further study can establish the relationship between activity and flake completeness for different material classes. Still, even with brittle materials, Sullivan and Rozen's method has some potential. In this analysis, the problems were compensated for somewhat by restricting recordation of certain variables (such as presence/absence of exterior cortex and number of flake scars) to whole flakes. Through this approach, variation observed within and between assemblages was more easily identified as resulting from differences in either material type or technology. For this analysis, the Sullivan and Rozen system was not relied on to infer cultural behavior, but rather was used to separate out differences in whole flakes.

As with any study involving Sullivan and Rozen's method, flake completeness was used only as a starting point in the US 54 debitage analysis. Other variables are needed in order to infer cultural behavior. For this study, the following 11 variables were analyzed in order to draw conclusions regarding the behavioral relationship between the different lithic assemblages: (1) flake completeness; (2) maximum length; (3) maximum thickness; (4) weight; (5) exterior cortex; (6) platform cortex; (7) platform type; (8) edge modification; (9) material type; (10) material texture; and (11) number of dorsal flake scars. Analysis of variables (5) and (11) was restricted to complete flakes, and for variables (6) and (7) was restricted to complete and broken flakes. All other variables were recorded for all flakes and debris.

*Flake completeness* is based on Sullivan and Rozen's (1985) method, and includes: (1) complete flakes; (2) broken flakes; (3) flake fragments; and (4) debris, as defined above.

*Maximum Length* is the maximum dimension for each individual flake, measured in 5-mm intervals (e.g., 0–5, 6–10, 11–15, etc.). Flake measurements were obtained by placing a flake onto a piece of paper, marked with 5-mm length intervals. To facilitate analysis, these categories were subsequently collapsed into five length groups (0–1 cm, 1–2 cm, 2–3 cm, 3–4 cm, and > 4 cm). Because each flake was assigned a flake size, it was possible to calculate an average and standard deviation for this variable. However, it should be noted that since each length was rounded up to the nearest 5 mm, this average has a slight error associated with it.

*Maximum Thickness* was measured for each individual flake in 1-mm intervals. Flake thickness was measured either with a dial caliper or by holding the flake up to a ruler. To facilitate analysis, flake intervals were combined into the following groups: 1 mm, 2 mm, 3 mm, 4–5 mm, 6–9 mm, and > 10 mm. As a metric measurement, it was possible to calculate average and standard deviations for this variable.

*Weight* was determined for each flake on a digital scale accurate to the nearest 0.1 gram. Some flakes did not register on the scale, and were assigned a weight of 0.0 grams. For the purpose of analysis, flakes were divided into the following weight groups: 0.0–0.1 grams, 0.2–0.4 grams, 0.5–1.0 grams, 1.1–2.0 grams, 2.1–5.0 grams, 5.1–10.0 grams, and > 10 grams. As a metric measurement, it was possible to calculate average and standard deviations for weight.

*Exterior Cortex* was recorded as a presence/absence variable on complete flakes only. A flake with any cortex outside of the striking platform was recorded as present.

*Platform Cortex* was recorded as a presence/absence variable on complete and broken flakes only (these are the only categories that include platforms). Presence was recorded if a striking platform contained any cortex.

*Platform Type* was recorded on flakes with striking platforms or the remnants of striking platforms. Four platform types were recorded. Unifaceted striking platforms have a flat striking platform.

Bifaceted striking platforms exhibit two facets on the striking platform. Multifaceted striking platforms contain more than two facets on the striking platform. Collapsed/crushed striking platforms are present when it is possible to identify the striking platform, but not what type due to damage caused during the reduction process. In the Sullivan and Rozen system, the latter are classified as flake fragments.

*Edge modification* was recorded for each flake showing regular edge-damage but no intentional retouch. Initially, three types of edge-modification were recorded. Edge-damage was considered *nibbled* when flake damage was transverse to the flake scar; this damage is associated with pulling the flake in a scraping motion. *Rounded* edge-damage is present when the modified edge was rounded; this would be more often associated with cutting activities. *Polish* was recorded for edges that showed polish, associated with repetitive motion like drilling. Due to the relatively small number of edge-modified flakes, and the potential interpretive problems associated with these categories, for the purpose of analysis all categories were combined into a simple category: edge-modified.

*Material Type* was recorded for each flake. During the analysis each material type was recorded with subdivisions for each lithic type. For example, there were at least seven varieties of rhyolite observed from the sites based on color and textural differences. Because most material types were relatively rare, it was decided to collapse the material types for the purpose of analysis into broader material groups. These groups include calcite, chert, glass, granite, hornfels, igneous, limestone, obsidian, quartz crystal, quartzite, rhyolite, sandstone, and silicified shale. Silicified shale and chert were by far the two most common material types (see the section on material types in this chapter for more specific information on these materials).

*Material Texture* includes three categories: fine, medium, and coarse. In fine materials the individual grains are not visible to the unaided eye and the texture feels smooth. In medium materials the material looks and feels rough, but grains are not easily visible. In coarse materials, the material feels quite rough and the individual grains are clearly visible to the unaided eye.

*Flake Scars* were recorded on the dorsal side of complete flakes. A greater number of flake scars is associated with more advanced stages of lithic reduction and platform preparation. Bifacial thinning flakes, for example, show more flake scarring than initial core reduction flakes (which may not have flake scarring, especially when cortex is extensive).

Three variables were recorded but not used in this analysis. First is the presence of *heat treatment*. This variable was not used because it was so infrequent as to be virtually non-existent. Heat treatment was not a significant factor in lithic manufacture on the sample of lithics collected from these sites. Second is the occurrence of flakes coming from *hammerstone fragments*. A total of seven flakes were manufactured from hammerstones, four from LA 115260 and three from LA 6829. Both sites are Formative in date and most of the flakes came from hammerstones of silicified shale. Due to the large number of flakes at both sites combined (more than 4,000), flakes from hammerstones are likely not a desired product, but rather an infrequent, incidental result of using an easily fracturable material for a hammerstone. Finally, *lipping*, a platform attribute, was recorded as present/absent, but was not used because relatively few flakes in this study exhibited lipping.

#### Interobserver Error Study

While most nondebitage lithic artifacts were all analyzed by a single analyst, four different analysts characterized the lithics for the debitage analysis. An interobserver error study was conducted to determine the comparability between researchers. For the purpose of this section, the observers are identified as Observer A, B, C, and D. The debitage analysis was distributed fairly

evenly between three main observers A, B, and C (accounting for 35 percent, 35 percent, and 28 percent of the total material analyzed respectively), leaving just two percent for observer D. All analysts had conducted lithic analysis in the past. Because of the large scale of this project, the analysts met before beginning this lithic analysis to discuss how the variables were being measured with the specific goal of reducing interobserver error. Due to the low number of flakes analyzed by Observer D, only Observers A, B, and C are compared in the following analysis.

The first step conducted in this study was to establish if there were any differences between the collections analyzed between observers that could not be due to interobserver error. This was accomplished by examining the metric traits of the debitage such as weight, length, and thickness, all nominal, objective measurements. As it turned out, however, differences between observers emerged in all three variables. In terms of weight, Observer B's data revealed the lightest flakes on average, with a mean of 1.63 grams. This was followed by Observer A's data, which produced a mean of 2.19 grams, and Observer C's, with an average of 3.24 grams. Since weights were measured for each flake on a digital scale, this measurement is completely objective, and reflects actual differences in flake weights (and hence size) between the observers. The variables maximum length and thickness confirm this pattern between observers.

Part of the reason for this difference in size can be explained by the analysis of surface versus subsurface contexts. Observer C analyzed the largest flake sizes, and also examined nearly 70 percent of the 749 surface artifacts. Surface artifacts are on average much larger and heavier than subsurface artifacts (more on this later). However, even examining only subsurface artifacts, the same bias was apparent. The most likely explanation for this is that different observers largely focused on different sites, which contained debitage assemblages of different character.

The main concern in this study was obviously not on the objective variables, but rather the more subjective ones. However, differences in subjective variables such as flake size can result from differences in objective variables, as flake size is correlated with variables such as completeness, edge-modification, and cortex (see Lundquist 2002). Controlling for flake size and material type, the one variable that consistently exhibited differences between observers was flake completeness, using the Sullivan and Rozen (1985) classification system. As mentioned above, this system was specifically developed to create an objective method of classifying flakes by their level of completeness. While some have criticized the Sullivan and Rozen method on its shortcomings in identifying inherent behavioral meaning, most agree that it is objective and replicable between observers. However, the US 54 results showed that interobserver error can indeed emerge in the identification of flake completeness categories.

Because the underlying advantage and strength of the Sullivan and Rozen system is challenged by these results, a detailed examination of the differences between observers on their classification of flake completeness was carried out. In so doing it quickly became apparent that the biggest differences emerged between Observer A on the one hand, and Observers B and C on the other. All observers sorted flakes into those with platforms and those without in about equal amounts. This suggests that there was no bias in observing the presence or absence of platforms, something that a trained lithic analyst should easily and correctly identify. Interobserver differences emerged, however, in the identification of flake fragments versus debris (both of which lack platforms) and complete versus broken flakes (both of which contain platforms). Overwhelmingly, Observer A classified flakes without platforms as debris, while Observers B and C classified more flakes as flake fragments. Accordingly, Observers B and C were recognizing and recording single interior surfaces (i.e., ripple marks on ventral sides) much more often than Observer A was. Observer A was



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also much more likely to record flakes with platforms as broken than either Observer B or C were.

One probable explanation for these differences is the individual analyst's familiarity with the Sullivan and Rozen system. Both Observer B and C were trained at the University of New Mexico by Dr. Bruce Huckell, an accomplished lithic analyst who studied at the University of Arizona while Sullivan and Rozen were developing their classification system there. In addition, Observer B and C had conducted large-scale lithic analyses using the Sullivan and Rozen system with encouraging results. Observer A, on the other hand, was a trained lithic analyst but had never used the Sullivan and Rozen system before, although the method was explained to this observer (as described above) prior to the analysis.

In the end, the results from the analysts were combined for all variables except for flake completeness. For flake completeness, only Observer B's and C's results were used. This was possible because Observer A only examined flakes from three of the larger sites, which were also examined in part by Observer B and C. In most cases a statistically representative sample size was possible even without the results from Observer A. The one exception was the Late Archaic component from site LA 128699. In this case, 100 flakes recorded by Observer A were randomly selected and re-examined by Observer C.

There are a few implications for future research based on this interobserver error study. First, the analysis results indicate the importance of conducting an interobserver error study when different analysts are involved in the same project. Second, when working with different analysts, a preliminary phase should be conducted, in which a small subset of artifacts is analyzed by all analysts involved and then examined for systematic biases. This would ensure better comparability of results early in the analysis stage. Third, and important for the use of the Sullivan and Rozen system, the results obtained here suggest that more thorough training in the Sullivan and Rozen method is required to ensure compatible results between analysts. Employing these various measures could help to minimize the kinds of interobserver error observed in this study. Finally, it should be noted that using different observers actually can be advantageous in a study of lithic materials; if just one observer was involved, a systematic bias could go unobserved and the results would unknowingly be incompatible with those of other researchers.

### Surface/Nonsurface Artifacts

The next step undertaken in the lithic analysis was to determine which flaked-stone artifacts could be combined for use in within-site and between-site analyses. A potential problem was immediately recognized with combining surface and non-surface contexts, because screening of excavated fill tends to recover flakes that are overall smaller than those recovered from surface collection. The same problem emerges between units screened with a 1/8-inch mesh compared to those screened with a 1/4-inch mesh. In this study that was not a significant problem, as more than 95 percent of the subsurface material collected was screened through a 1/8-inch screen. In the following analysis, debitage referred to as subsurface artifacts includes only that recovered with 1/8-inch screen, while all other debitage is treated as "surface."

In Table 21.17, the results of a chi-square analysis of 11 variables between surface and subsurface artifacts are listed. Two variables, material texture and platform type, were not significant at the 0.05 level. Except for cortex, which was significant at the 0.02 level, all other variables were highly significant (at least the 0.001 level). As expected, surface artifacts are longer, heavier, thicker, show more edge-modified flakes, are more often complete, and contain more cortex than subsurface flakes. Following is an examination of the significant variables and a discussion of the implications for future research.

Statistically, there are highly significant differences in flake length between surface and subsur-



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face deposits ($\chi^2$=401.3, p<0.001). Figure 21.7 presents a plot of the adjusted chi-square residuals of maximum flake length (in cm) by provenience for all sites. Surface debitage is significantly longer on average (over two cm) than subsurface flakes, which are biased towards smaller (less than two cm) pieces. For the study area, the average surface flake maximum length is 2.8 cm, with a standard deviation of 1.4 cm. Subsurface flakes average 1.9 cm in maximum length with a tighter standard deviation of 1.0 mm. Clearly surface collected flakes are much longer than subsurface flakes.

There are also highly significant differences in flake weight between surface and subsurface deposits ($\chi^2$=485.0, p<0.001). Figure 21.8 presents a plot of the adjusted chi-square residuals of flake weight (in grams) by provenience for all sites. Surface deposits are biased towards flakes weighing more than 2.0 grams as compared to subsurface deposits, which are biased towards flakes weighing less than 0.5 grams. Between 0.5 and 2.0 grams there is not a significant difference in flake weights. For the study area, the average surface flake weight is 7.3 grams, with a standard deviation of 32.8 grams. Subsurface flakes average 1.6 grams in weight with a tighter standard deviation of 5.3 grams. Clearly, surface collected flakes are much heavier than subsurface flakes.

As for maximum flake thickness, there are also highly significant differences between surface and subsurface assemblages ($\chi^2$ =302.5, p<0.001). Figure 21.9 presents a plot of the adjusted chi-square residuals of flake thickness (in mm) by provenience for all sites. Surface deposits are biased toward flakes thicker than 5 mm as compared to subsurface deposits, which are biased towards flakes thinner than 4 mm. Between 4–5 mm there is not a significant difference in flake thickness. For the study area, the average surface flake thickness is 6.7 mm, with a standard deviation of 5.7 mm. Subsurface flakes average 4.0 mm in thickness, with a tighter standard deviation of 3.3 mm. Surface collected flakes are much thicker than subsurface flakes.

Highly significant differences were also found in material type between surface and subsurface deposits ($\chi^2$ =243.5, p<0.001). Figure 21.10 presents a plot of the adjusted chi-square residuals of grouped material types by provenience for all sites. Surface deposits are biased towards chert, granite, igneous, and rhyolite materials, while subsurface deposits contain more silicified shale than expected. There are no significant differences between limestone, obsidian, and quartzite between the surface and subsurface deposits. The surface deposits indicate an overrepresentation of durable materials, while the subsurface deposits are biased towards the easily fractured silicified shale. One likely explanation is that the surface materials were preferentially (although unconsciously) collected based on larger flake sizes, which is suggested by the much larger flake size,

**Table 21.17 Results of a Chi-Squre Analysis on Surface Versus Subsurface Debitage**

| Variable | Chi-square Value | Probability | Surface Debitage |
|---|---|---|---|
| Length | 401.3 | p<0.001 | Longer |
| Weight | 485 | p<0.001 | Heavier |
| Thickness | 302.5 | p<0.001 | Thicker |
| Material Type | 243.5 | p<0.001 | More durable material |
| Material Texture | 2.6 | p=0.271 | No difference |
| Completeness | 59.4 | p<0.001 | More whole flakes |
| Edge Modification | 104.7 | p<0.001 | More edge modification |
| Platform Type | 4.3 | p=0.116 | No difference |
| Platform Cortex | 20.4 | p<0.001 | More present |
| Cortex | 5 | p<0.026 | More cortex |
| Count of scars | 26 | p<0.001 | Fewer scars |



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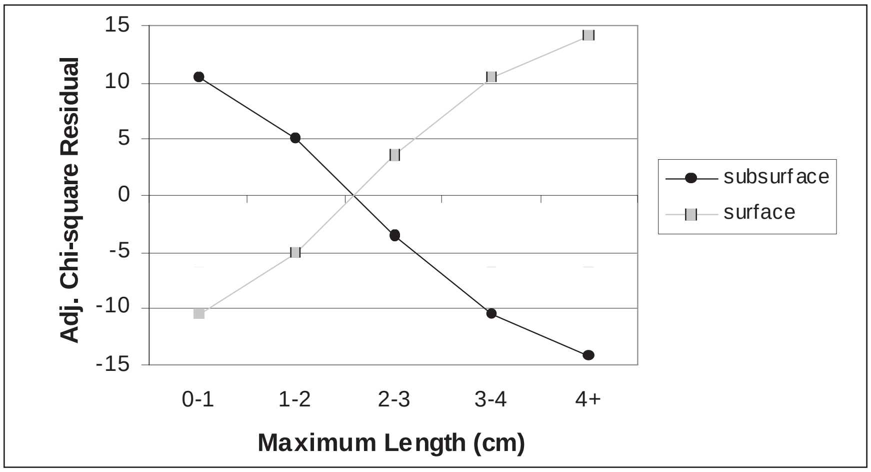


**Figure 21.7 Adjusted chi-square residuals on flake length by provenience for all sites.**

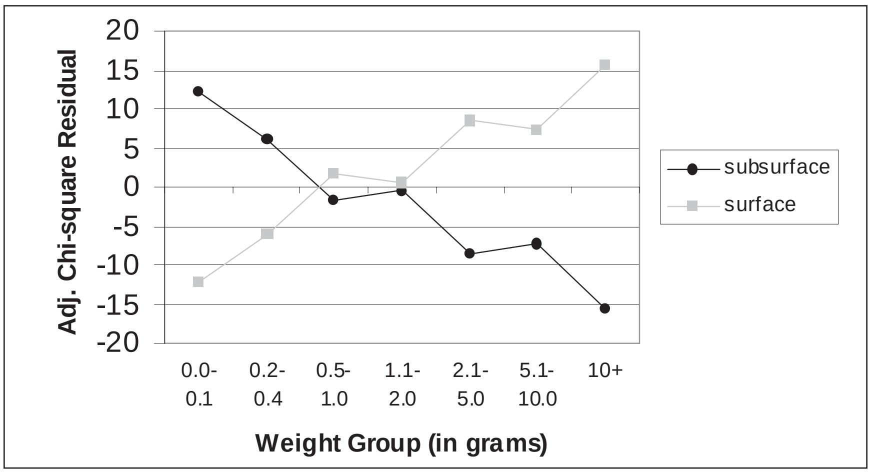


**Figure 21.8 Adjusted chi-square residuals on flake weight by provenience for all sites.**

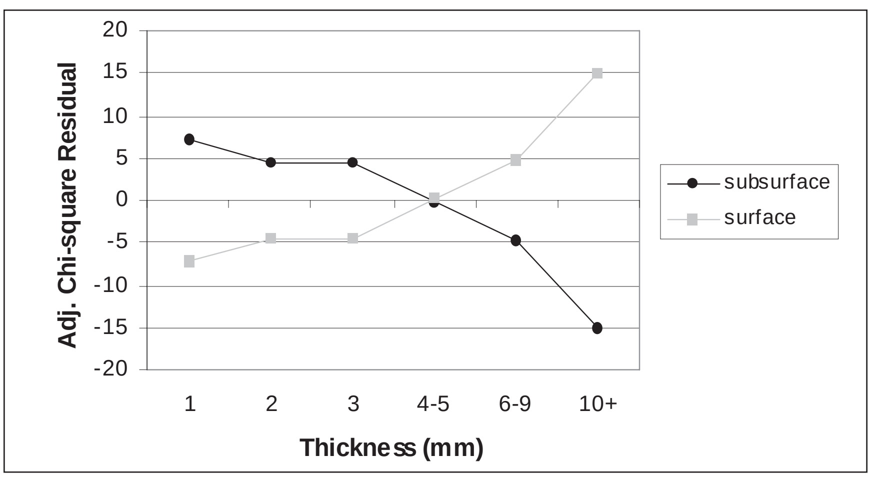


**Figure 21.9 Adjusted chi-square residuals on flake thickness by provenience for all sites.**



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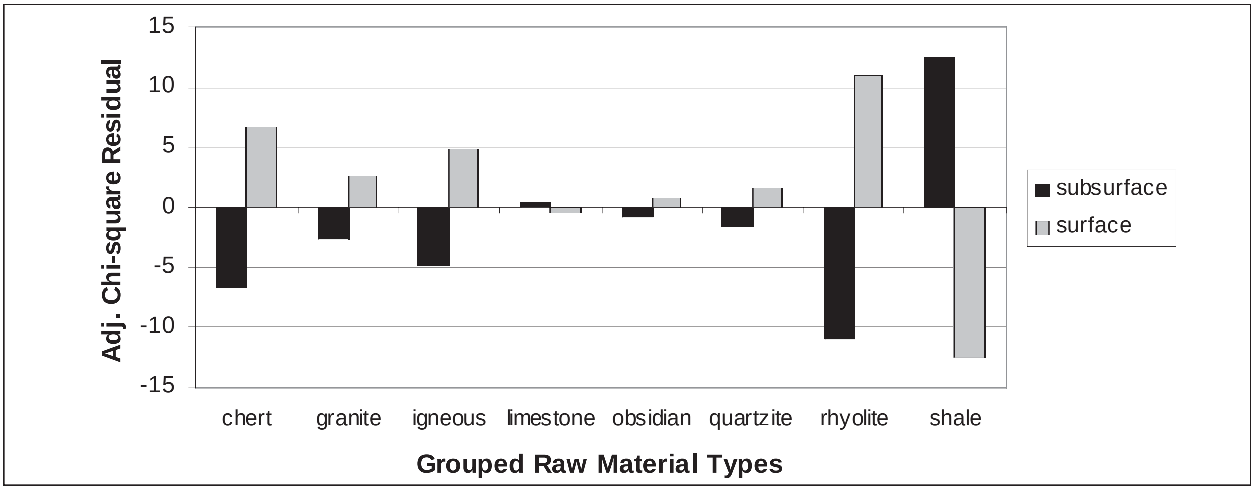


**Figure 21.10 Adjusted chi-square residuals on material type by provenience for all sites.**

weight, and thickness of surface flakes. Easily fractured materials like silicified shale would have been crushed over time into smaller flake sizes, making them less visible and therefore less likely to be collected on the surface.

There are highly significant differences in flake completeness, based on Sullivan and Rozen's (1985) method, between surface and subsurface deposits ($\chi^2$=59.4, p<0.001). Figure 21.11 presents a plot of the adjusted chi-square residuals of flake completeness by provenience for all sites. Surface deposits are biased towards complete flakes, while subsurface deposits contain more flake fragments and debris than expected. There are at least two explanations for this. First, whole flakes are typically larger than non-complete flakes, and would therefore be more visible on the surface. Second, whole flakes are easier to identify as cultural artifacts than flake fragments. Taken together, this indicates a systematic bias in flake identification during surface collection, as well as a bias toward larger, more complete flakes on site surfaces.

Highly significant differences also emerge in terms of edge modification between surface and subsurface assemblages ($\chi^2$ =104.7, p<0.001). Figure 21.12 presents a plot of the adjusted chi-square residuals of edge modification on flakes by provenience for all sites. Surface deposits are

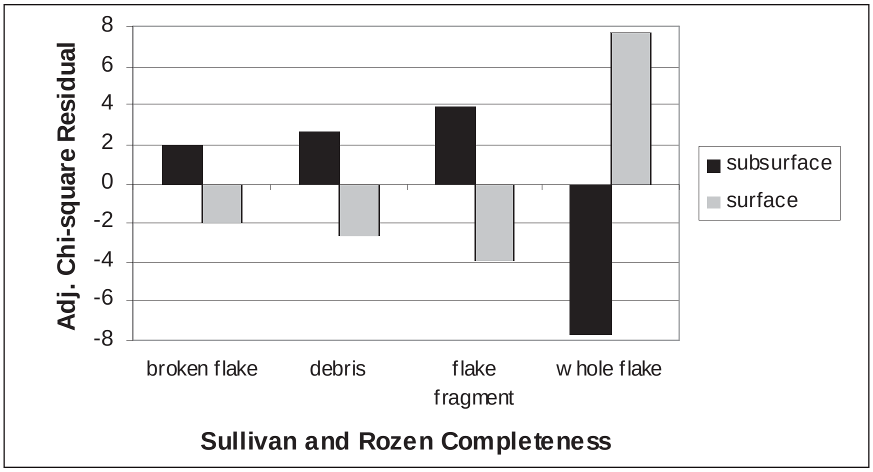


**Figure 21.11 Adjusted chi-square residuals on flake completeness by provenience for all sites.**



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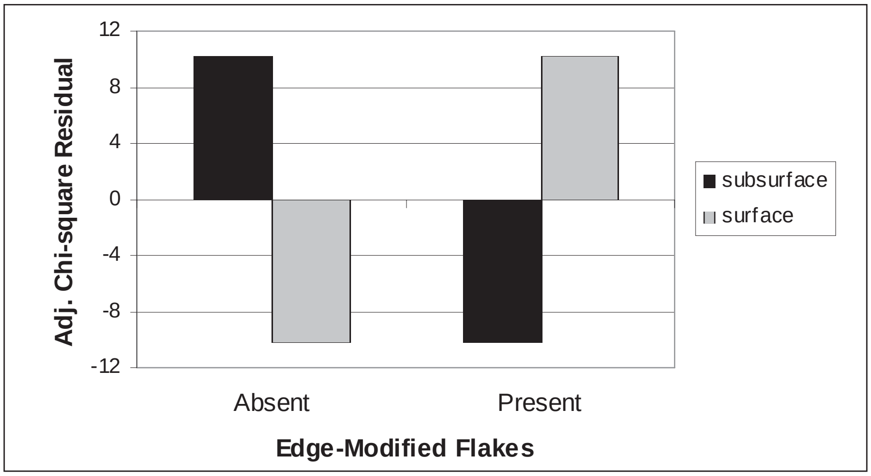


**Figure 21.12 Adjusted chi-square residuals on edge modification by provenience for all sites.**

biased towards flakes that have been edge-modified (expedient flakes), while subsurface deposits contain fewer edge-modified flakes than expected. Edge modification is correlated with larger flake sizes (see Lundquist 2002) in part because larger flakes lend themselves to use as expedient tools. Since edge-modification is a function of larger flake size, and larger flake sizes are associated with surface artifacts, the presence of significantly more edge-modified flakes on the surface may be epiphenomenonal to flake size.

Surface and subsurface assemblages also exhibit highly significant differences in platform cortex ($\chi^2$=20.4, p<0.001). Figure 21.13 presents a plot of the adjusted chi-square residuals of striking platform cortex on flakes by provenience for all sites. Surface deposits are biased towards flakes with platform cortex, while subsurface deposits contain fewer platforms with cortex than expected. Since the surface artifacts are larger, it might be expected that there would be more cortex on the surface flakes. Usually, but not always, platform cortex is associated with initial stages of core reduction, which as a byproduct produces larger flakes on average than later stages of reduction. Because the surface artifacts represent a biased sample of larger artifacts, the higher percentage of cortex is not surprising.

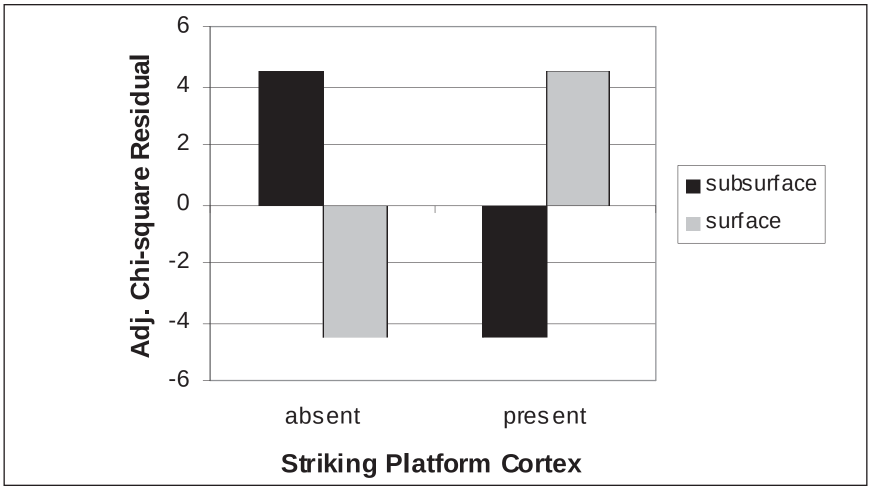


**Figure 21.13 Adjusted chi-square residuals on platform cortex by provenience for all sites.**

As with platform cortex, there are also significant differences between surface and subsurface deposits in cortex observed on whole flakes ($\chi^2$=5.0, p<0.026). Figure 21.14 presents a plot of the adjusted chi-square residuals of cortex on whole flakes by provenience for all sites. Surface deposits are slightly biased towards flakes with cortex while subsurface deposits contain somewhat less cortex than expected. As with platform cortex, the presence of cortex on a flake might be expected to correlate with flake size, as larger flakes are usually closer to initial stages of reduction than very small flakes. That this is only a weak correlation is probably explained by the fact that, overall, cortex was not common in the US 54 flake assemblages. Only 27 percent (n=341) of whole flakes and only 16 percent (n=912) of all flakes contained any cortex at all, suggesting that initial reduction was not taking place at the sites.

There are significant differences in the number of flake scars (observed on whole flakes only) between surface and subsurface deposits ($\chi^2$=26.0, p<0.001). Figure 21.15 presents a plot of the adjusted chi-square residuals of flake scars on whole flakes by provenience for all sites. Surface deposits are biased towards flakes with fewer scars (less than two) while subsurface deposits contain two scars more frequently than expected. Flakes with three or more scars are not common (making up only one-fifth of the total complete flakes) and are not significantly different between surface and subsurface contexts. Based on the presence of larger flake sizes and more platform and body cortex on flakes from surface contexts, fewer flake scars might be expected. This is because relatively more of the surface flakes are associated with early-stage reduction, which produces more flakes with cortex and fewer flake scars than does later stage reduction.

From the results presented here, it is clear that there are significant differences between lithic debitage from surface and subsurface contexts. In general, the surface debitage is larger, heavier, thicker, has more cortex on both the flake body and striking platform, and is more often edge-modified than subsurface debitage. Thicker flakes and durable materials are more likely to remain relatively whole, and therefore be larger and more visible on the landscape than smaller flakes. Flakes collected from the surface are also more frequently complete and of a durable material.

This result has important implications for lithic analyses based on surface survey materials only. Without a comparative assemblage from corresponding subsurface contexts, site flaking activities would likely be falsely biased towards early-stage reduction and expedient use. The surface-subsurface differences may be due in part to the variable tendencies of vertical migration between

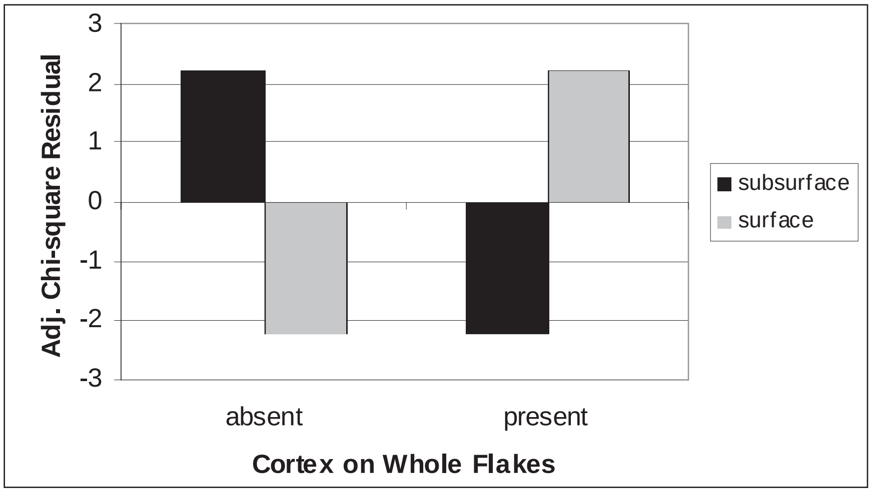


**Figure 21.14 Adjusted chi-square residuals on cortex by provenience for all sites.**



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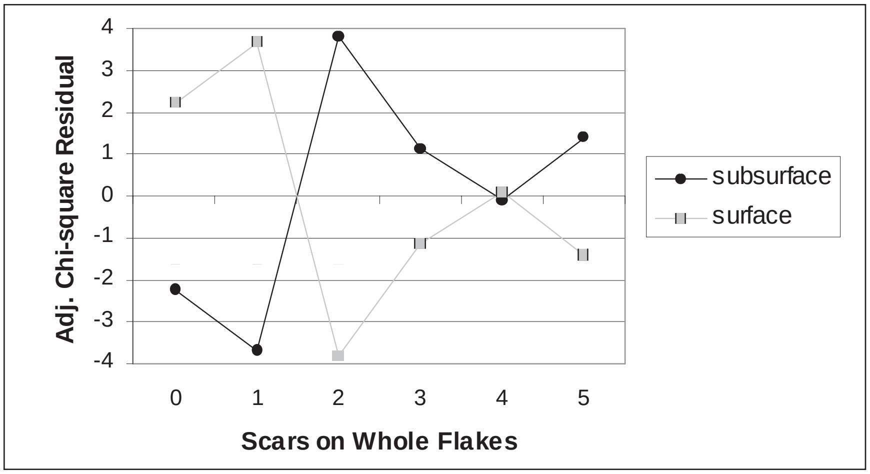


**Figure 21.15 Adjusted chi-square residuals on flake scars by provenience for all sites.**

smaller versus larger flakes, i.e., smaller flakes will tend to migrate downward into the subsurface (due to soil cracking, bioturbation, trampling, etc.) and thus "disappear" from the surface at a rate faster than larger flakes would. Perhaps more importantly, the results probably also indicate collector bias in surface assemblage, with surface collectors recovering larger, more visible flakes at a higher rate than smaller, less visible ones. Lacking a systematic method of collecting surface artifacts, including smaller, less visible flakes (which are routinely recovered from subsurface contexts through fine screening), this bias will continue. One recommendation would be to more intensively collect/record all artifacts in evenly spaced 1 x 1-m units in a given direction from a site datum on surveys instead of the frequently practiced random method, which is necessarily biased towards larger flakes that are easily visible from a standing height.

Lithic analysts often recognize that surface artifacts are not a direct reflection of subsurface artifacts but may not recognize the extent of the potential differences between surface and subsurface assemblages. Almost every single variable is statistically significantly different between the surface and subsurface, even within a single site. The major implication of this study is that surface and subsurface assemblages cannot be combined without compromise. Surface debitage characteristics simply do not correspond closely to subsurface artifacts (except perhaps in cases where flaking activities at a site truly were restricted to early stage reduction).

To illustrate the importance of this consideration, take the large Formative-period site LA 6829. If this site were surveyed, the surface lithics would be examined without knowledge of the subsurface artifacts. We would know that this site was large due to the large number of ceramics (over 15,000) and many exposed features. The surface debitage includes mostly large flakes that are frequently edge-damaged and have up to 40 percent presence of cortex. If only the 216 surface lithics were analyzed, we would conclude that the surface artifacts represent simple expedient tool use for this large Formative-period site. Looking at the subsurface artifacts that were collected through controlled screening, however, we see the bias introduced by surface assemblages and collection techniques. Compared to the subsurface assemblage, flakes on the surface are on average 1.5 times longer, 3.6 times heavier, and 1.8 times thicker. In short, they are significantly larger, which is a hallmark of expedient use. Other indicators of expedient use are also over-represented at this site. Surface flakes are, on average, three times more likely to be edge-modified, 1.6 times more likely to contain cortex, and 1.4 times more likely to exhibit striking platform cortex. Even the



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material types are more evenly distributed between material classes on the surface. The overall surface debitage suggests a simple pattern of picking up a random piece of raw material, knocking off a few flakes, and using a large flake for an expedient task. Looking at the subsurface artifacts in a screened environment, a different pattern emerges—one in which one material class (in this case silicified shale) dominates, where small flakes are common, and cortex is relatively uncommon. In short, we see a picture of long-term, intensive lithic reduction more consistent with the large and relatively long-term occupation at LA 6829.

One variable that is probably accurately reflected between surface and subsurface contexts is the estimate of subsurface assemblage size based on the count of surface finds. Figure 21.16 shows the strong positive ($r$=0.75) correlation between the log of subsurface and surface lithic counts. Note that this chart does not reflect complete lithic counts from both surface and subsurface contexts (as with most excavations, the subsurface context was sampled). For the entire study area, collected subsurface artifacts were 6.5 times more common than surface artifacts. One obvious implication of this finding is that on similar projects with similar intensity of surface collection and subsurface sampling, we could predict roughly 6.5 times the surface debitage in subsurface remains. Further work along these lines may be useful to survey crews who are tasked to predict the total assemblage size based just on the number of surface artifacts.

As only 13 percent of the total material recovered was collected from surface contexts, these data were not included in the between-site analysis, presented below. Rather, the focus of this analysis was on the 87 percent of material excavated in a controlled context screened through 1/8-inch screen. The surface artifacts were not ignored, however. Because the surface artifacts were collected across the entire surface of a site (as opposed to subsurface artifacts, which were collected from the more spottily located excavation units and features), the surface artifacts were gainfully used in examining spatial patterning within sites (see in particular Chapters 14 [LA 128699] and 15 [LA 128700]). Additionally, the debitage descriptions in the site chapters, which focus on simple artifact counts and material type within a site, combine surface and subsurface artifacts together.

### *Lithic Material Use*

One of the goals of this study was to examine the relationships between known lithic source areas and material exploitation at US 54 sites. One common perception in the study of lithics is that

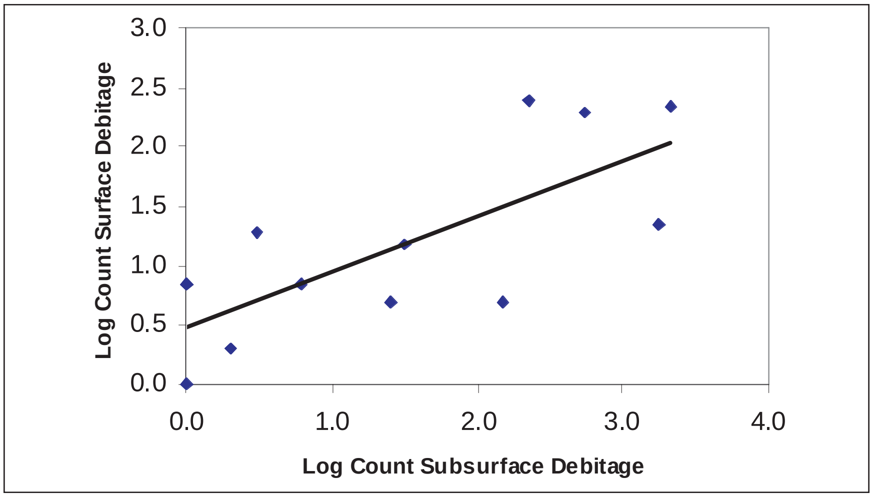


**Figure 21.16 Correlation of log counts between surface and subsurface contexts.**

as one moves back further into prehistory, the distance (and hence variety) of lithic materials exploited increases. For example, during the Paleoindian period chipped stone artifacts on sites often come from great distances, as much as 300 km. During the Ceramic period, the geographic focus of material types is greatly reduced to mostly local materials. In this study materials sources from subsurface contexts were grouped by type (i.e., all cherts were combined, all rhyolites were combined, etc.) and compared to the total count of debitage pieces analyzed. There was a maximum of 10 grouped lithic materials per site, but the count of lithics ranged from one to more than 2000. In order to control for differences in scale, the lithic counts were transformed using a simple log base 10 transformation. The results are plotted in Figure 21.17. The strong positive correlation of 0.98 (with 1.0 being a perfect correlation) indicates that for these sites there is a significant relationship between the number of flakes counted and the number of material types at a site. Because the sites in the study can be dated to both the Archaic and the Formative period, this suggests that the perception that a greater range of material types (including more distant sources) were exploited in earlier periods may not always hold true. Alternatively, the results may indicate that the reduced geographic scope of lithic procurement occurred in this area during Archaic times and held steady throughout the Formative period. At any rate, for the sites in this study the number of material types exploited is a function of total lithic assemblage size, where larger assemblages have a greater variety of material types. This same pattern holds true for the number of species identified in faunal assemblages, as pointed out by Grayson (1984), and can be thought of in terms of richness. Richness in this case is the number of grouped material types present, in this case a maximum of ten.

This does not mean that there is no difference between Archaic- and Formative-period sites in terms of raw material exploitation. While richness does appear to be a function of assemblage size, evenness does not. Evenness is defined as the distribution of flakes by material type within a site. An assemblage is more even if the counts of lithics are equally distributed between the material types. Nearly 80 percent of the Late Formative lithic debitage was composed of silicified shale, an uneven distribution. For the Archaic, the dominant material class was chert, at 53 percent. Looked at another way, the least common seven grouped material types in the Archaic assemblages make up 12 percent of the total lithic material, compared to under two percent for those dating from the Formative period.

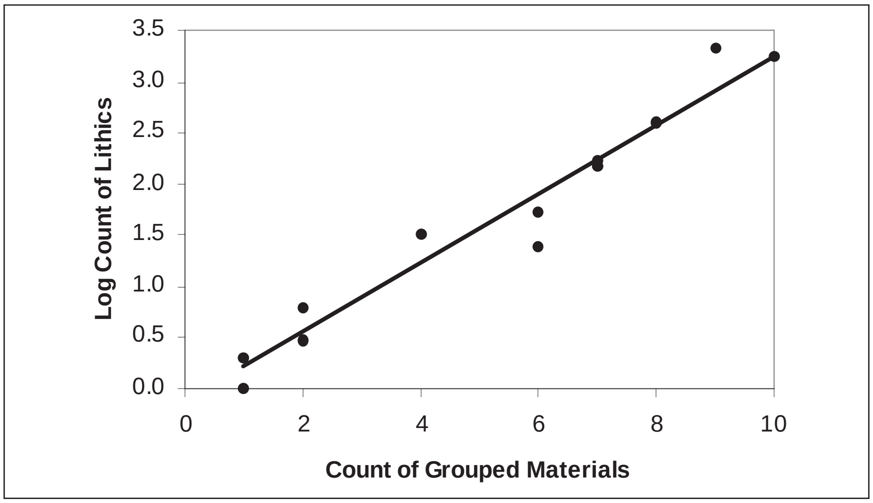


**Figure 21.17 Correlation between grouped materials and Log(10) count of lithics for all sites in the study area.**



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This strongly suggests that there is a local difference in the availability of these two materials. While cherts are widely abundant in the mountains throughout the study area, and there are chert sources in the Jarilla Mountains, it is likely that silicified shale represents a much more "local" material for the inhabitants of LA 6829 and the surrounding sites than chert does. The geological literature suggests that this material is abundant in the sedimentary rocks of the Jarillas and that there may be a source for this material extremely close to LA 6829 (see Lithic Materials section in this chapter). If this is the case, then if we assume similar lithic procurement strategies, we would expect abundance of silicified shale in site assemblages to decrease as distance from this source increases. Indeed, slight clustering evident on the distributional map provided by Carmichael (1986:175) suggests that the frequency of sites containing silicified shale increases as distance to the Jarillas (and LA 6829) increases.

In order to test this, as well as to evaluate whether the source is the Jarilla Mountains in general, or the area around LA 6829 in particular, we calculated the distances between each site and two points: (1) the center of the Jarilla Mountains, hypothesizing that silicified shale might be procured from several portions of these mountains; and (2) LA 6829, hypothesizing that the main silicified shale source is actually on or very near this site. We then correlated each of these distance measurements with the relative abundance of silicified shale within each site assemblage, including only those sites that contained silicified shale. The correlation between silicified shale abundance and distance to the center of the Jarillas was weakly negative, and was not significant, with a correlation coefficient of -.477 and significance level of 0.138. However, the negative correlation between shale abundance and distance to LA 6829 itself was significant, with a correlation coefficient of -.630 and significance level of 0.038. This relationship is weakened by the inclusion of LA 128699 and LA 128700, both of which are dominated by chert and have strong Late Archaic components. Figure 21.18 is a scatterplot showing the relationship between distance to LA 6829 and silcified shale abundance.

These Late Archaic sites likely violate the assumption that lithic procurement strategies are similar at all sites. If we remove them from the sample, the correlation between distance and silicified shale abundance is made stronger, with a correlation coefficient of -.837 and a significance level of 0.005. When these sites are removed, the only site that does not rest almost exactly on a line with the others is LA 126181. It is possible that the small sample size from this site (fewer than 25 pieces) is responsible for this anomaly.

Based on this analysis, we argue that silicified shale is a much more locally available material in this region than chert is, and that lithic procurement practices changed between the Late Archaic and Formative periods from an emphasis on high-quality cherts to lower-quality, locally available materials. While during the Formative period people were willing to use other material types, they were not necessarily willing (or able) to travel far to get them, as evidenced by the fact that the most commonly exploited material is the one geographically closest and that use of other material classes was rare.

More importantly, the use of variable material types during the Formative period may even be a function of resource procurement during the Archaic. Because Archaic people were apparently more discriminating in the materials selected, using more high-quality lithic materials such as chert and rhyolite, they would have had to initially procure these materials, in some cases from sources not located in the immediate vicinity of the sites. Chipped stone debris left over from Archaic occupations was probably scavenged from the surface by Formative peoples who reoccupied these sites. Thus, such materials would have been viewed as "local" by the Formative occupants, even though their geological source of origin may have been more distant. This recycling of raw materials is certainly evident at the Formative periods components of Orogrande Site 1 (LA 128699) and LA 128700, both of



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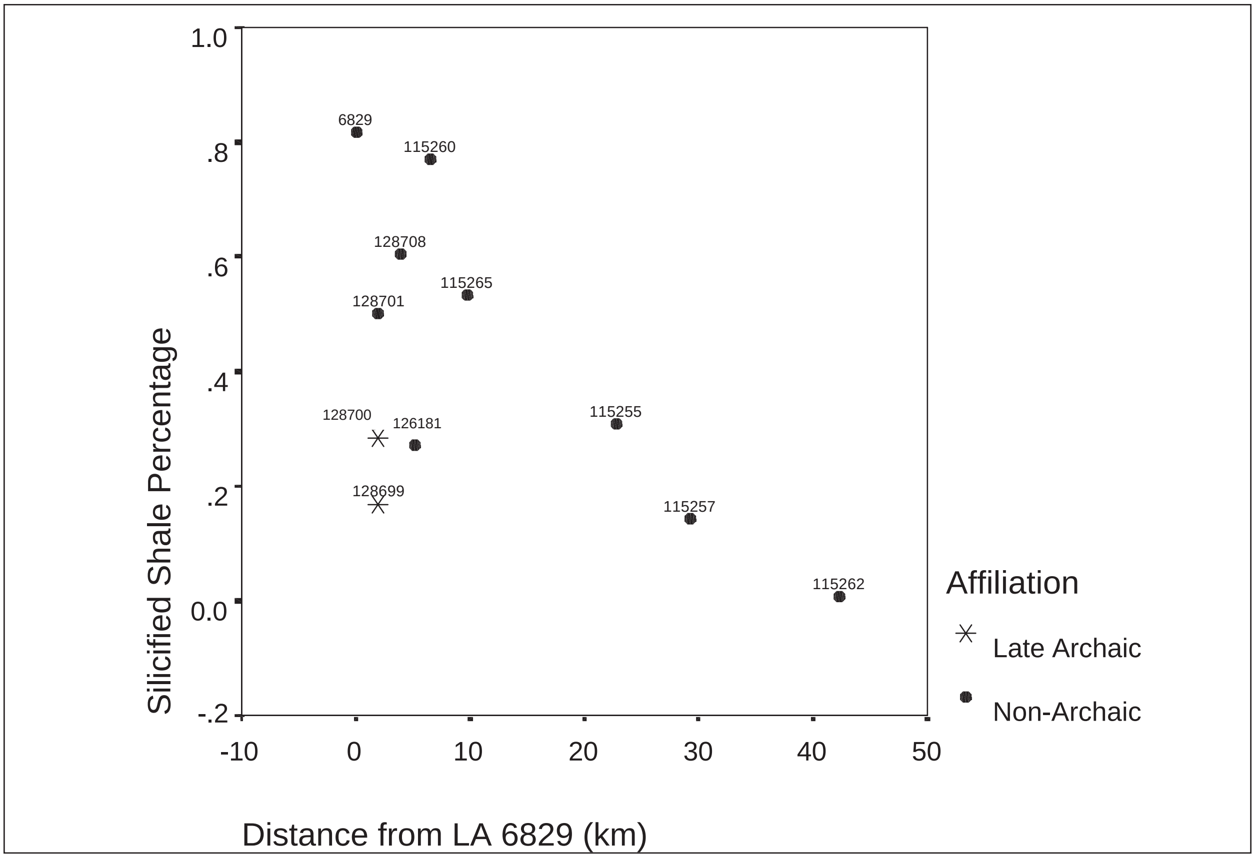


**Figure 21.18 Scatterplot of US 54 sites, showing negative relationship between distance to LA 6829 and proportional abundance of silcified shale. Only sites including silicified shale were included.**

which have Archaic and Formative components and have an uncharacteristically large percent of chert and rhyolite in the Formative-period debitage assemblages. On the other hand, the two large Formative-period sites (Jaca [LA 6829] and LA 115260) are not located on or near any Archaic-period remains, and the debitage assemblages from these sites are overwhelmingly dominated by silicified shale, although a variety of other material classes occur as well in small percentages.

From the findings presented here, the conventional perception that earlier sites contain more material classes appears to be true more in terms of evenness than in terms of richness. It also appears to be true in terms of material quality, regardless of distance to the source—Archaic peoples seem to have preferred higher-quality cherts and rhyolites, as opposed to Formative knappers who were willing to settle for lower-grade materials. In part this is probably a function of lithic material recycling by the opportunistic Formative-period occupants, who might not go out of their way for high-quality material but would preferentially use it whenever it was locally available (either in its geological source or as archaeological debris that could be scavenged). It is also apparent that low-quality lithic materials weren't shunned by the Archaic inhabitants, who occasionally and opportunistically used the poor-quality, but local, silicified shale, albeit at a much reduced rate than during the Formative period.

### General Site Characteristics

Controlling for interobserver error and differences between surface and subsurface artifacts, we can now discuss the general site characteristics for the study area. As shown in Table 21.16 (see above), a total of 16 sites contained lithic artifacts collected from either the surface or subsurface contexts. Appendix D provides summary data on the variables analyzed for all surface level lithic debitage by site, as well as the same information for subsurface lithic debitage. For each assemblage (listed by column), counts are given for each of the variables studied. Below the table of raw counts is a table of percentage (by assemblage). For example, 178 pieces of chert were analyzed from subsurface contexts at LA 6829, which account for 8.4 percent of the total subsurface lithic assemblage for this site. Variables include grouped materials, flake completeness using the Sullivan and Rozen (1985) system, material texture, maximum length in five groups, average length (for the entire assemblage), maximum thickness in six groups, average thickness (for the entire assemblage), weight in seven groups, average weight (for the entire assemblage), platform type, lipping, edge modification, cortex (on complete flakes), number of flake scars (on complete flakes), and platform cortex (on flakes with platforms). Definitions of these variables can be located above in this chapter. These data form the basis for the following site analyses.

### Comparison of Temporal Components Across All Sites

Given the presence of components ranging from the Late Archaic to Late Formative periods in the US 54 sites, part of the lithic analysis focused upon exploring differences in debitage signatures from different time frames. In general, the Archaic period in the Southwest is characterized by soft-hammer manufacture of shaped tools, while the Formative period is characterized by intensive core reduction, resulting in usable flakes with little or no modification (Chapman 1977:447; Olszewski and Simmons 1982:113; Sullivan and Rozen 1985:766). As discussed in the Methods section above, cultural affiliation categories include Late Archaic (2500 B.C.–250 A.D.), Formative (A.D. 250–1425), mixed (lithic components sharing both Archaic and Formative-period materials), and unknown (not enough information available). Because there were only nine lithics collected in subsurface contexts from the unknown sites, they were not included in the following analysis. Archaic assemblages come from the one component each at the otherwise mixed sites LA 128699 and LA 128700. As discussed above in the “Analytical Methods” section, and in Chapters 14 and 15, these components could be segregated from the smaller Formative-period assemblages at these sites. The Formative-period components include LA 6829 and LA 115260, both large assemblages. The mixed assemblages include one site with complete overlap between the Archaic and Formative assemblages (LA 115262) and two sites that are dominantly Archaic in character but have features that have been dated to the Formative period (LA 128699 and LA 128700); Here, the two components could not be cleanly separated.

Table 21.18 lists the results of a chi-square analysis of 10 variables between Archaic, Formative, and Mixed period sites. Four variables, edge-modification, platform type, platform cortex, and cortex, were not significant at the 0.05 level. All other variables were highly significant at the 0.006 level or higher. As expected, Archaic assemblages can be distinguished from Formative ones, but also from mixed assemblages. Further verification that separating the Archaic from the mixed assemblages in sites LA 128699 and LA 128700 was obtained, as the two assemblages on each site are shown to be significantly different in character. An examination of the significant variables and a discussion of the results follows.

There are highly significant differences in flake length across time ($\chi^2$=100.4, p<0.001). Figure 21.19 presents a plot of the adjusted chi-square residuals of maximum flake length (in cm) across time. Archaic assemblages are significantly shorter (0–1 cm) than either Formative or Mixed assemblages and contain significantly fewer

**Table 21.18 Results of a Chi-square Analysis of Variables Across Time**

| Variable | Chi-square Value | Probability | Significant Results |
|---|---|---|---|
| Length | 100.4 | p<0.001 | Archaic shortest |
| Weight | 66.6 | p<0.001 | Archaic lightest |
| Thickness | 39.4 | p<0.001 | Archaic thinnest |
| Material Type | 1826.9 | p<0.001 | More chert and rhyolite for Archaic and mixed, more silicified shale for Formative |
| Completeness | 17.9 | p<0.006 | Fewer flake fragments, more whole flakes mixed |
| Edge Modification | 5.2 | p=0.075 | No significant difference |
| Platform Type | 6.2 | p=0.187 | No significant difference |
| Platform Cortex | 4.9 | p=0.088 | No significant difference |
| Cortex | 0.1 | p=0.955 | No significant difference |
| Count of scars | 44.2 | p<0.001 | Fewer scars for Archaic on whole flakes. |

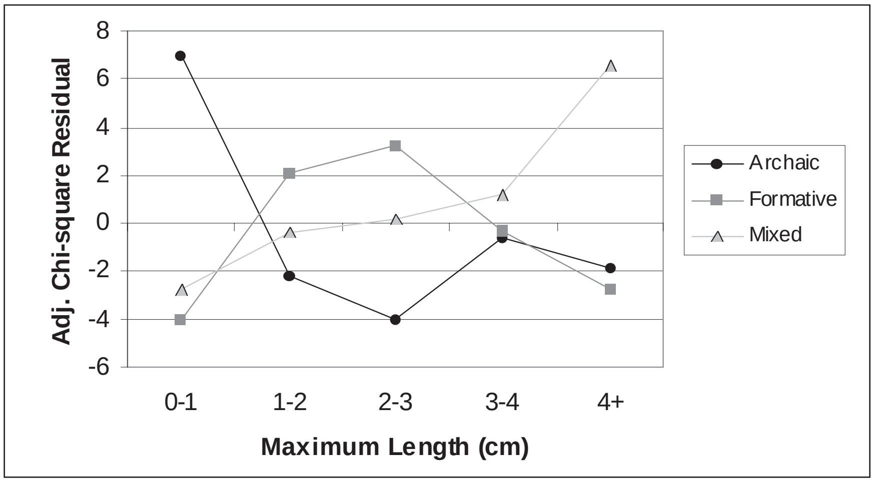


**Figure 21.19 Adjusted chi-square residuals on maximum flake length over time.**

medium-sized (1–3 cm) flakes. Formative assemblages contain more medium-sized flakes (1–3 cm) than either Archaic or mixed assemblages. Mixed assemblages include significantly more large flakes (over 4 cm). For the Archaic assemblages, the average flake length is 1.7 cm, with a standard deviation of 0.9 cm. Formative flakes average 1.9 cm in maximum length, with a standard deviation of 0.9 cm. Mixed flakes average 2.2 cm, with a standard deviation of 1.3 cm. In general the trend is for small flakes from the Archaic assemblages, medium flakes from the Formative assemblages, and larger flakes from the Mixed assemblages.

For flake weight there are also highly significant differences across time ($\chi^2$=66.6, p<0.001). Figure 21.20 presents a plot of the adjusted chi-square residuals of flake weight (in grams) across time. Archaic assemblages contain significantly lighter (0–0.1 grams) flakes than either Formative or Mixed assemblages. Formative assemblages contain slightly more medium-weight flakes (2.1–5.0 grams). Mixed assemblages include significantly more heavy flakes (more than 10 grams) as compared to Formative and Archaic assemblages, where this weight class is underrepresented. For the study area, the Archaic flakes are the lightest overall, with an average weight of 1.06 grams and a standard deviation of 2.69 grams. Formative flakes average 1.43 grams in weight, with a standard deviation of 4.7 grams. Mixed flakes are heaviest with an average weight of 3.07 grams and a standard deviation of 1.3 grams. In general the trend follows that of

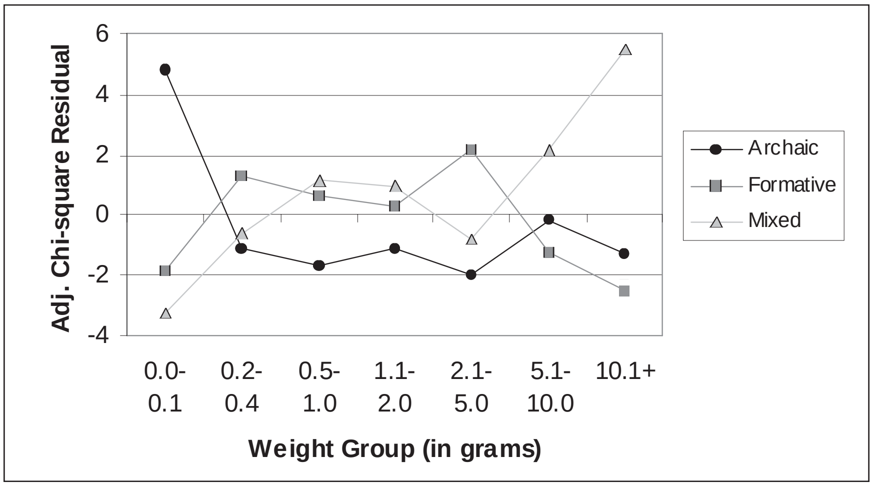


**Figure 21.20 Adjusted chi-square residuals on flake weight over time.**

flake length with light flakes from the Archaic assemblages, medium flakes from the Formative assemblages, and heavy flakes from the mixed assemblages.

There are also significant differences in flake thickness across time ($\chi^2$=39.4, p<0.001). Figure 21.21 presents a plot of the adjusted chi-square residuals of maximum flake thickness (in mm) across time. Archaic assemblages are significantly thinner (2 cm) than either Formative or Mixed assemblages. Interestingly, Formative assemblages contain slightly fewer of the thickest flakes (over 10 mm) than either Archaic or Mixed assemblages. Mixed assemblages are marked by significantly fewer thin (1 mm) flakes and more thick (over 10 mm) flakes. For the study area, the average Archaic flake thickness is 3.73 mm, with a standard deviation of 3.02 mm. Formative flakes average 3.93 mm in maximum thickness, with a standard deviation of 3.07 mm. Mixed flake thickness averages 4.94 mm, with a standard deviation of 4.34 mm. In general the trend follows that of flake weight and length, and is for thinner flakes from the Archaic assemblages, medium flakes from the Formative assemblages, and thicker flakes from the Mixed assemblages.

There are extremely significant differences in use of material type across time ($\chi^2$=1826.9, p<0.001).

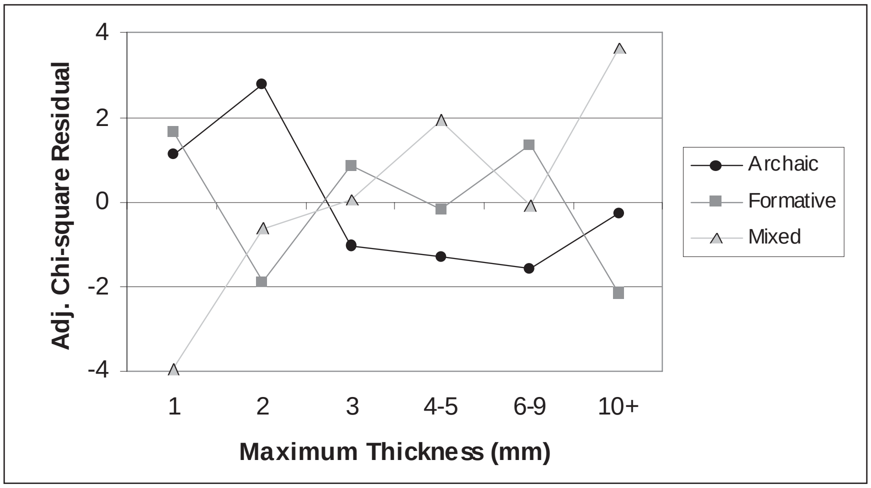


**Figure 21.21 Adjusted chi-square residuals on flake thickness over time.**

Figure 21.22 presents a plot of the adjusted chi-square residuals of grouped material types across time. Archaic assemblages contain significantly more chert, rhyolite, and igneous material and less limestone and silicified shale than expected. Formative assemblages are almost the opposite of Archaic assemblages. Mixed assemblages contain less silicified shale than expected, but more chert, granite, igneous, and limestone than expected. There are no temporal differences in the use of obsidian, quartzite, or sandstone, all uncommon materials. The Archaic and mixed assemblages are similar in many ways, which is to be expected. Because the dominantly Formative-period mixed assemblages at LA 128699 and LA 128700 are situated on the same sites with strong Archaic components, it is suggested that the mixed portion of assemblage represents reuse/recycling of the high-quality lithic materials (chert and rhyolite) from the Archaic component. Naturally, because the mixed assemblages contain remains intermingled from both Archaic and Formative activities, these assemblages also contain an unknown percentage of non-recycled Archaic material. Limestone and granite, which do not show up in the Archaic-only assemblages, do appear in the Mixed assemblage, and provide further support for the distinction between these two analytical components. Formative-period sites are dominated by one raw material, silicified shale, which makes up over 80 percent of the total subsurface assemblage. The evidence from the mixed assemblages is that Formative-period flintknappers may have preferred to use high-quality materials, but not enough to go out of their way to obtain it (or perhaps were discouraged from doing so by territorial circumscription at this time). For the Formative-period sites with no Archaic component, that meant using the brittle, low-quality, but easily available silicified shale. It should be noted that even in the Archaic period silicified shale was exploited (17 percent), being easily obtained and flakeable, but not nearly to the same extent as chert (almost two-thirds of the assemblages).

There are statistically significant differences in flake thickness across time ($\chi^2$=17.9, p<0.006). Figure 21.23 presents a plot of the adjusted chi-square residuals of flake completeness over time. Archaic assemblages do not significantly deviate from the expected values. Formative assemblages contain slightly fewer whole flakes, probably a result of a reliance on the brittle silicified shale for 80 percent of the assemblage. Mixed assemblages are marked by significantly fewer flake fragments and more whole flakes. Because almost 70 percent of the total lithic assemblage is comprised of the easily fractured silicified shale, the behavioral meaning behind these differences in flake completeness cannot be ascertained.

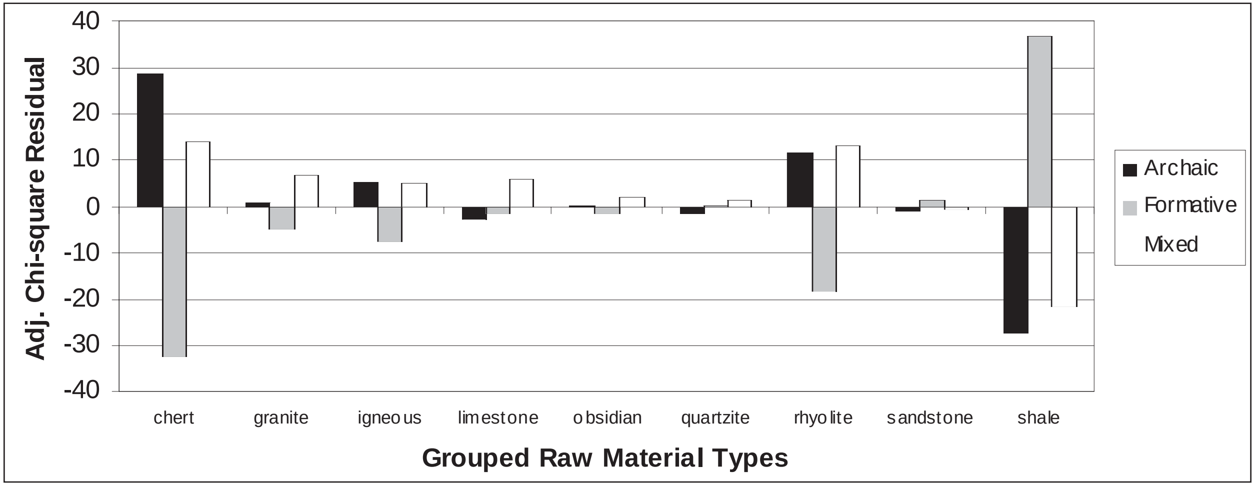


**Figure 21.22 Adjusted chi-square residuals on material type over time.**



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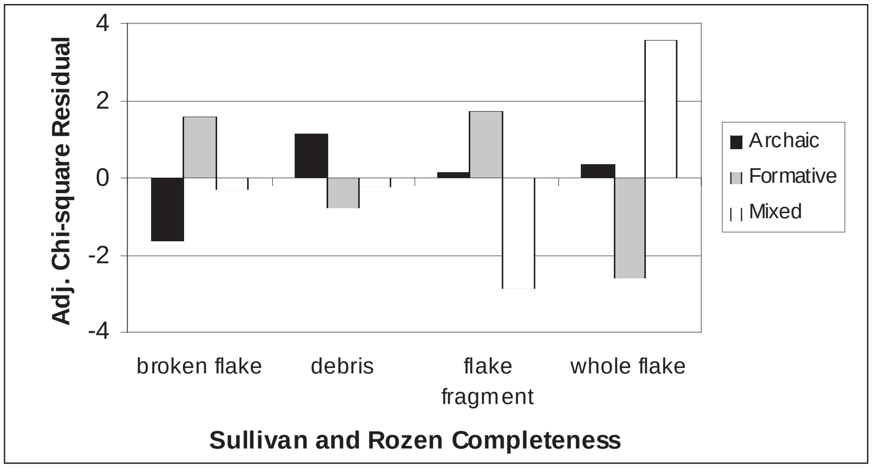


**Figure 21.23 Adjusted chi-square residuals on flake completeness over time.**

There are statistically significant differences in the number of flake scars on whole flakes across time ($\chi^2$=44.2, p<0.001). Figure 21.24 presents a plot of the adjusted chi-square residuals of flake scars on whole flakes over time. Archaic assemblages contain more flakes with less than 0–1 flake scars and more than 5–6 flakes scars compared to the Formative and Mixed assemblages. Presence of more flake scars is expected during the Archaic, but because flake sizes are also much smaller, the surface area for flake scars is reduced resulting in an abundance of flakes with few flake scars.

From the above results it is clear that there are significant differences over time in the nature of the debitage assemblages. During the Archaic, the focus was on high-quality materials such as chert and rhyolite, materials that could probably have been obtained within the territorial range of a mobile hunter-gatherer group. These materials were worked intensively, likely for formal tool manufacture, based on the small weight, size, and thickness of most of the flakes. The occasional use of silicified shale, an inferior but easily obtainable lithic resource, combined with the use of edge-modified flakes suggests the Archaic flintknapping technology also included a more expedient component, albeit a minor one. During the Formative period, a focus on easily obtainable lithic resources is apparent, as exemplified with an increase in use of silicified shale to over

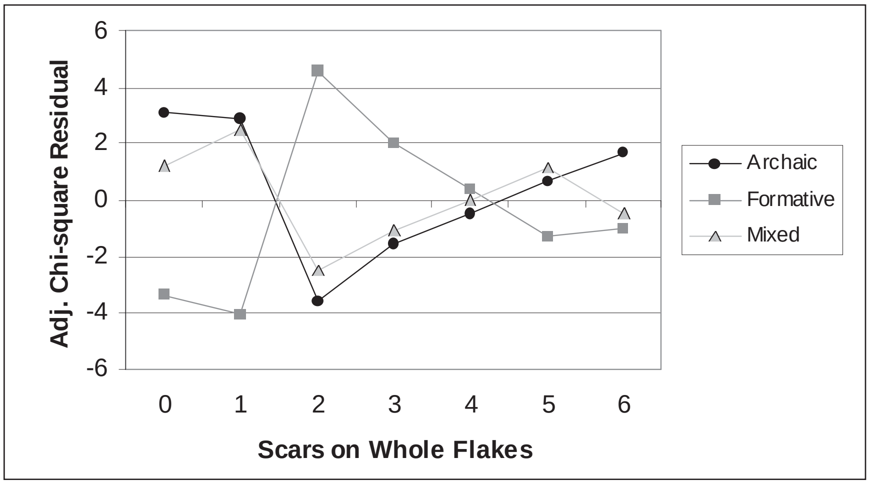


**Figure 21.24 Adjusted chi-square residuals on scar count on whole flakes over time.**

80 percent of the debitage assemblages. Flake weight, length, and size also increase, despite the reliance on the easily fractured silicified shale, indicating less formal tool manufacture (in particular biface manufacture, which produces numerous thin light flakes).

The mixed assemblages, which include both Archaic and Formative flintknapping waste, underscore the flexible nature of the Formative-period lithic industry. In this case, cherts and rhyolites left behind by the Archaic occupations provided a "local" source, along with the inferior-quality silicified shale. The higher incidence of cherts and rhyolites in the Formative debitage assemblages at the mixed sites suggests that high-quality materials were probably desired, but not enough to warrant expeditions to collect them from the foothills of the nearby mountains. Unlike during the Archaic period, where mobility was higher and group territories were perhaps larger and more open, higher-quality, nonlocal materials were more easily obtained, and this activity was probably integrated into relatively wide-ranging, mobile subsistence-settlement patterns. During the Formative period, when groups were more sedentary, subsistence was more focused on agriculture, and group territories were perhaps more circumscribed. Access to higher-quality chert and rhyolite source localities may thus have been restricted, or at least the Formative inhabitants did not take the trouble to venture the distance required to procure these materials from their geological sources. Regardless, in all cases minimal effort was expended in transporting raw materials back to a site, as evidenced by the small amount of cortex and platform cortex observed, even in the Archaic assemblages. Whether transporting chert or silicified shale, from far or near, the material was first reduced elsewhere, which is to be expected given the need to reduce the weight of loads transported on foot, as well as testing the quality of raw materials at their source.

#### Comparison of the Two Large Formative Assemblages

The debitage assemblages from the two large Formative-period assemblages (LA 6829 and LA 115260) were examined for comparative purposes. As shown above, Formative-period lithic assemblages in general are distinct from Archaic assemblages. But it remains to be seen how similar or dissimilar the Formative assemblages are to each other. In Table 21.19, the results of a chi-square analysis of 10 variables between the two sites suggest that almost every aspect of lithic manufacture is different between the two sites. Only two variables, platform cortex and exterior cortex, were not significantly different at the 0.05 level. All other variables were highly significant (at the 0.007 level or greater). Following is an examination of the significant variables and a discussion of the results.

There are highly significant differences in flake length between the two sites ($\chi^2$=85.9, p<0.001). Figure 21.25 presents a plot of the adjusted chi-square residuals of maximum flake length between the two large Formative-period sites. Flakes from LA 6829 are significantly longer (more than 2 cm) than flakes from LA 115260, which contain more flakes in the 1–2 cm size class. Very small flakes (less than 1 cm) are not significantly different between the two assemblages. The average flake length at LA 6829 is 2.0 cm, with a standard deviation of 1.1 cm. LA 115260 flakes are slightly shorter on average with 1.8 cm in maximum length and a standard deviation of 0.7 cm. In general it appears that lithics were more intensively reduced at LA 115260, with the exception of flakes less than 1 cm. This may be due to the expedient flake tool technology common on Formative-period sites; flakes less than 1 cm are not very useful tools, and therefore might be a by-product of attempting to manufacture larger flakes.

There are also highly significant differences in flake weight between the two sites ($\chi^2$=110.3, p<0.001). Figure 21.26 presents a plot of the adjusted chi-square residuals of flake weight (in grams) between the two large Formative-period sites. Flakes from LA 6829 are significantly heavier (more than 1 gram) than flakes from LA 115260, which contain more flakes less than



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**Table 21.19 Comparison of LA 6829 and LA 115260 (Large Formative Sites)**

| Variable | Chi-square Value | Probability | Significant Results |
|---|---|---|---|
| Length | 85.9 | p<0.001 | 6829 larger flakes |
| Weight | 110.3 | p<0.001 | 6829 heavier flakes |
| Thickness | 111.8 | p<0.001 | 6829 thicker flakes |
| Material Type | 144.5 | p<0.001 | 6829 more shale, quartzite, igneous, and granite |
| Material Texture | 138.1 | p<0.001 | 6829 more medium-grained flakes, fewer fine-grained |
| Completeness | 15.4 | p<0.002 | 6829 more debris, fewer flake fragments |
| Edge Modification | 7.3 | p<0.007 | 6829 more edge-modified |
| Platform Type | 125.9 | p<0.001 | 6829 more unifaceted, fewer multifaceted and crushed |
| Platform Cortex | 3.2 | p=0.073 | No difference |
| Cortex | 0.9 | p=0.341 | No difference |
| Count of scars | 113.5 | p<0.001 | 6829 fewer flake scars |

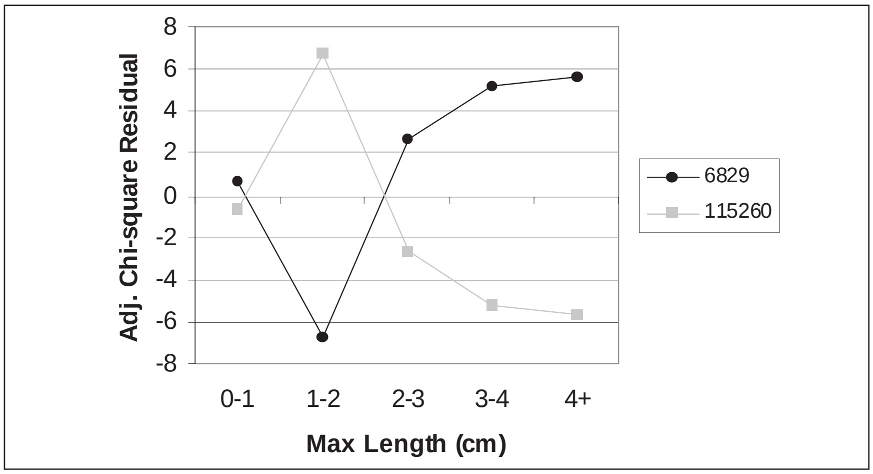


**Figure 21.25 Adjusted chi-square residuals on flake length between LA 6829 and LA 115260, two large Formative-period lithic assemblages.**

1 gram. The average flake weight at LA 6829 is 1.93 grams, with a standard deviation of 6.05 grams. LA 115260 flakes are significantly lighter on average with 0.82 grams in weight and a much tighter standard deviation of 1.94 grams.

There are highly significant differences in maximum flake thickness between the two Formative sites ($\chi^2$=111.8, p<0.001). Figure 21.27 presents a plot of the adjusted chi-square residuals of maximum flake thickness between the two large Formative-period sites. Flakes from LA 6829 are significantly thicker (> 6 mm) than flakes from LA 115260, which contain more flakes in the 2–3 mm thickness class. Very thin flakes (less than 1 mm) are not significantly different between the two assemblages. The average flake thickness at LA 6829 is 4.30 mm, with a standard deviation of 3.46 mm. LA 115260 flakes are thinner, averaging 2.48 mm in thickness, with a standard deviation of 3.04 mm. Again, it appears that lithics were more intensively reduced at LA 115260, with the exception of flakes less than 1-mm thick. This may be due to the expedient flake tool technology common on Formative-period sites; flakes less than 1-mm thick make easily broken tools, and therefore might be a by-product of attempting to manufacture larger flakes.

Examination of material type also reveals highly significant differences between the two sites ($\chi^2$=144.5, p<0.001), despite the fact that at a



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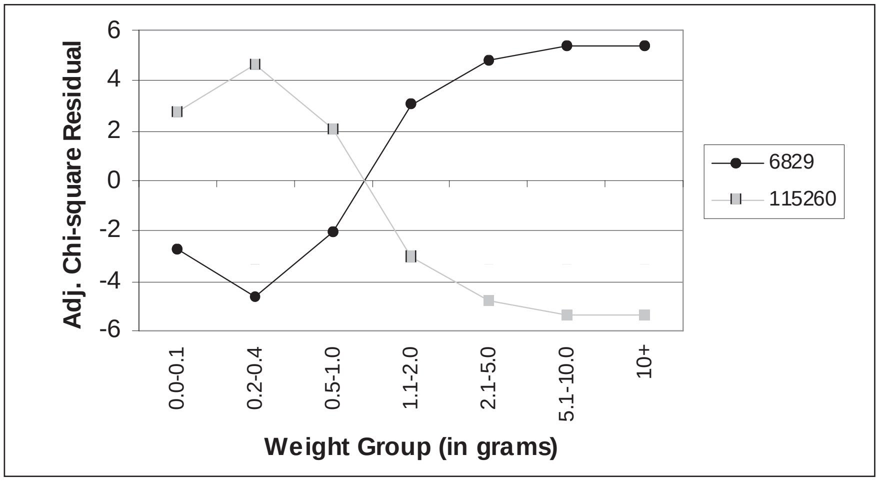


**Figure 21.26 Adjusted chi-square residuals on flake weight between LA 6829 and LA 115260, two large Formative-period lithic assemblages.**

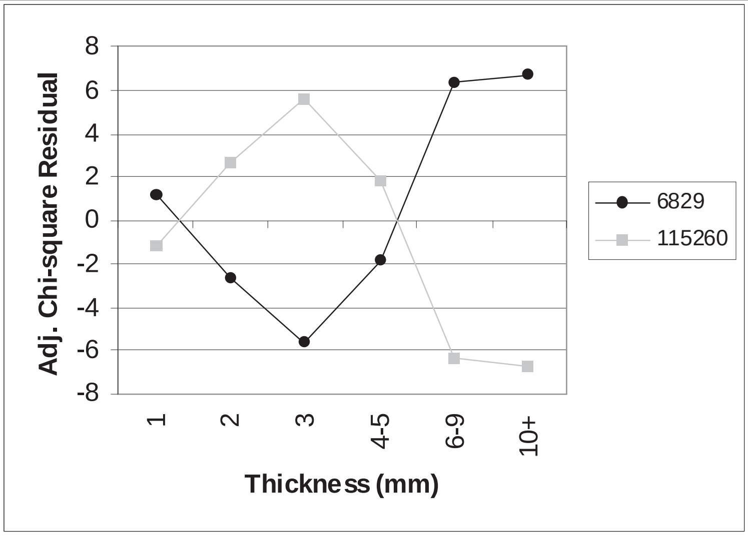


**Figure 21.27 Adjusted chi-square residuals on flake thickness between LA 6829 and LA 115260, two large Formative-period lithic assemblages.**

superficial level both sites are dominated by silicified shale (83 percent of subsurface material at LA 6829 versus 77.4 percent at LA 115260). Figure 21.28 presents a plot of the adjusted chi-square residuals of grouped material types between the two large Formative-period sites. LA 6829 contains significantly more granite, igneous, quartzite, and silicified shale than LA 115260, which contains more chert and limestone. There were no significant differences in the distribution of obsidian and rhyolite between the two assemblages, but both of these material types were rare (only 23 out of 3,743 flakes, or less than 1 percent). LA 115260 contains a significant amount of limestone (108 pieces in a screened, subsurface context), a poor-quality lithic material that was in general found in larger flake sizes. Whether or not these differences in material type are responsible for the differences in size of flakes between the two sites will be examined at the end of this section.



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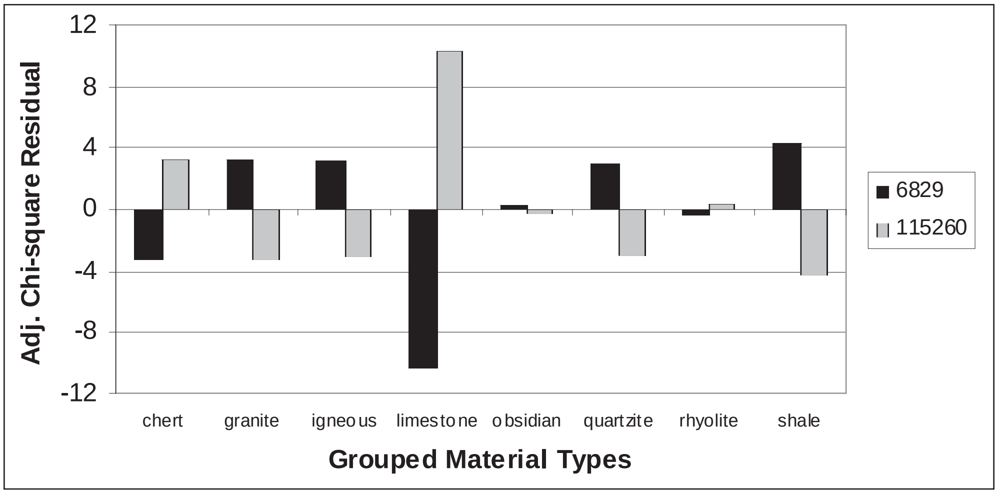


**Figure 21.28 Adjusted chi-square residuals on material type between LA 6829 and LA 115260, two large Formative-period lithic assemblages.**

There are statistically significant differences in material texture between the two sites ($\chi^2$=138.1, p<0.001). Figure 21.29 presents a plot of the adjusted chi-square residuals of material texture between the two large Formative-period sites. LA 6829 contains significantly more medium-grained material than LA 115260, which contains more fine-grained material. There were no significant differences in the distribution of coarse materials between the two sites. These results are not surprising given the differences in material types, with LA 6829 containing more medium-grained materials such as igneous and quartzite.

Statistically significant differences also emerge in flake completeness between the two sites ($\chi^2$=15.4, p<0.002). Figure 21.30 presents a plot of the adjusted chi-square residuals of flake completeness between the two large Formative-period sites. LA 6829 contains significantly more debris than LA 115260, which contains more flake fragments. There were no significant differences in the distribution of whole or broken flakes (i.e., flakes with platforms). LA 6829 contained more quartzite, granite, and igneous material, all coarser-grained material types in which characteristics of flake fragments are difficult to read, potentially resulting in their classification as debris.

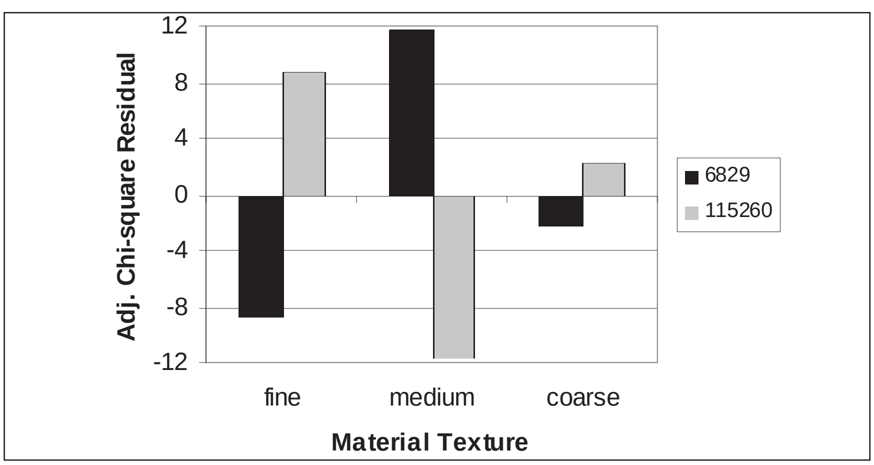


**Figure 21.29 Adjusted chi-square residuals on material texture between LA 6829 and LA 115260, two large Formative-period lithic assemblages.**

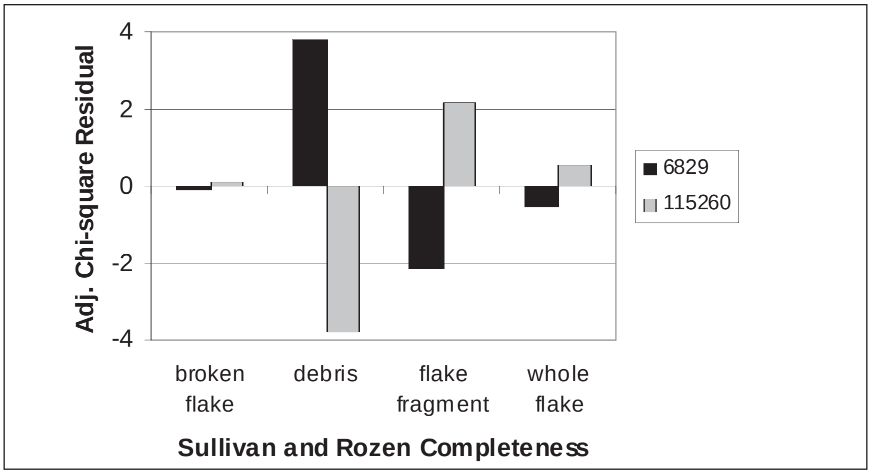


**Figure 21.30 Adjusted chi-square residuals on flake completeness between LA 6829 and LA 115260, two large Formative-period lithic assemblages.**

There are also statistically significant differences in presence of edge-modification between the two sites ($\chi^2$=7.3, p<0.007). Figure 21.31 presents a plot of the adjusted chi-square residuals of edge-modified flakes between the two large Formative-period sites. LA 6829 contains significantly fewer edge-modified flakes than LA 115260. This result is somewhat surprising, as LA 6829 contains larger flakes on average than LA 115260, and edge-modification is generally correlated with flake size. For both sites, however, edge-modification was rare, less than four percent of the total flakes. Another possible explanation is interobserver bias on identifying edge-modification. Three observers analyzed the debitage assemblages from LA 115260 and LA 6829, with uneven distribution of analysts' time for each site. Because there were so few edge-modified flakes overall, a slight bias in identifying damage as edge-modification could potentially result in a significant difference overall. The main conclusion that should be drawn from this is that edge-modification for both assemblages was present but in small frequencies (less than four percent).

There are highly significant differences in striking platform type between the two sites ($\chi^2$=125.9,

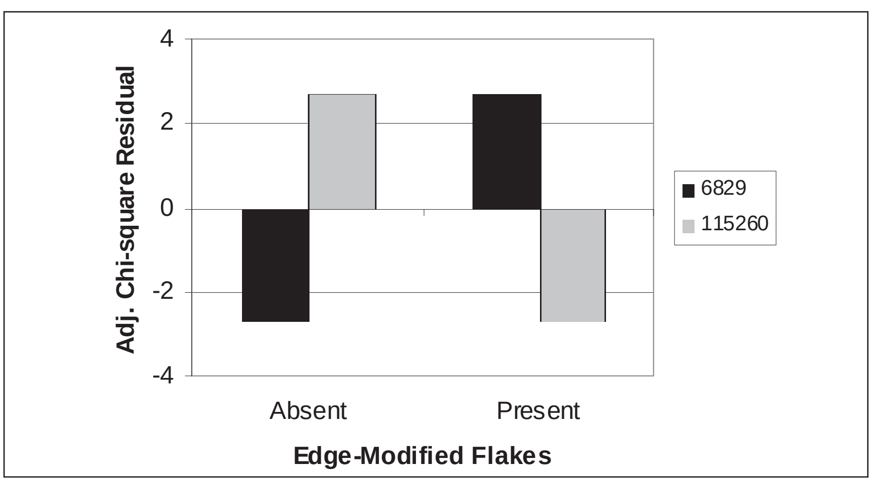


**Figure 21.31 Adjusted chi-square residuals on presence of edge-modification on flakes between LA 6829 and LA 115260, two large Formative-period lithic assemblages.**



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p<0.001). Figure 21.32 presents a plot of the adjusted chi-square residuals of platform type between the two large Formative-period sites. LA 6829 contains significantly more flakes with unifaceted platforms than LA 115260, which contains more flakes with multifaceted and crushed striking platforms. Both crushed platform and multifaceted platform types suggest more intensive flake reduction was taking place at LA 115260 than at LA 6829.

There are also highly significant differences in the number of flake scars on whole flakes between the two sites ($\chi^2$=125.9, p<0.001). Figure 21.33 presents a plot of the number of flake scars on whole flakes between the two large Formative-period sites. LA 6829 contains significantly fewer flake scars (with the one flake scar-category being over-represented) compared with LA 115260, which contains more flake scars than expected in the two, three, and four–flake scar categories. These data support the results of the striking platform type; more flake scars are associated with more intensive reduction, which characterizes the LA 115260 assemblages as different than LA 6829.

It is apparent that these two large Formative-period sites are different in terms of lithics characteristics. There are other differences that may help explain the discrepancies found in the lithics. LA 6829 is a much larger site, with more than 200 features and 17,000 ceramics, and dates a little later (22 dates averaging ca. A.D. 1150) as compared with LA 115260, which has less than 50 features, only 2,500 ceramics, and, based on the few radiocarbon dates, may be earlier (three dates averaging ca. A.D. 900). Because the radiocarbon dates overlap at least in part, it is likely that site size and function has more explanatory potential than does time in this case.

Material type is one factor that may explain differences in flake size between the two sites. In Table 21.20, the weight of flakes (in grams) between the two assemblages for chert, limestone, quartzite, and silicified shale is listed. These four material types comprise over 98 percent of the total subsurface lithic assemblage at these two sites. It is clear that for all material types, flakes are lighter at LA 115260—for the most part at least 50 percent lighter. Because this pattern holds for every type of material, the question is whether or not this is the product of cultural activity or some non-cultural phenomenon.

If the difference between the two sites were a product of non-cultural activity, such as trampling, this should be evident by the flake completeness. If there are more broken flakes and flake fragments or debris at LA 115260, this could support the hypothesis that the flakes are smaller

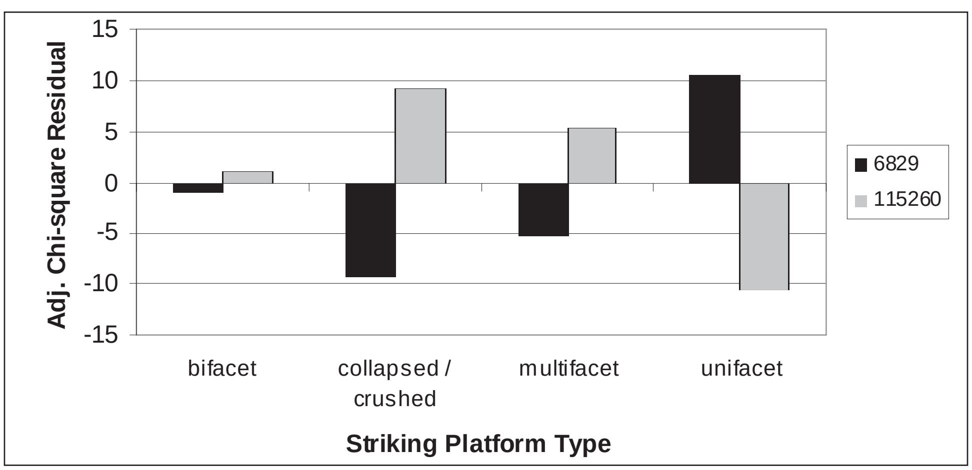


**Figure 21.32 Adjusted chi-square residuals on striking platform type between LA 6829 and LA 115260, two large Formative-period lithic assemblages.**

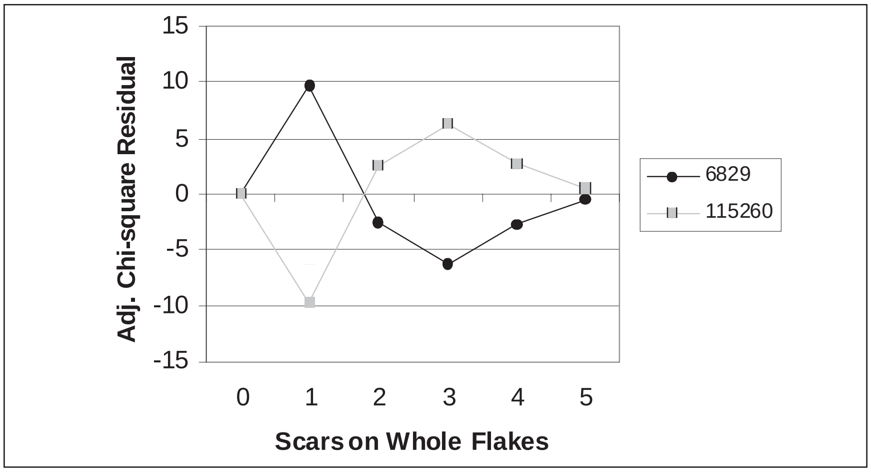


**Figure 21.33 Adjusted chi-square residuals on scar counts between LA 6829 and LA 115260, two large Formative-period lithic assemblages.**

**Table 21.20 Average Weight of Flakes from LA 6829 and LA 115260 by Selected Material Classes**

| Site | Chert | Limestone | Quartzite | Silicified Shale | Total |
|---|---|---|---|---|---|
| 6829 | 1.52 | 6.9 | 1.84 | 1.86 | 1.85 |
| 115260 | 0.75 | 1.09 | 0.57 | 0.81 | 0.81 |
| Total | 1.11 | 1.49 | 1.4 | 1.39 | 1.37 |

because of post-occupational surface trampling. However, as seen above in the flake completeness results, this is not the case. Proportional to the assemblage size there are just as many flakes with platforms at both sites, and there are just as many whole flakes (i.e., there are no significant differences in these measures between the two sites).

There are some indications that the differences in the debitage assemblages observed are the result of cultural activity. Flakes with platforms indicate more intensive reduction was taking place at LA 115260, based on the higher proportion of multifaceted and crushed striking platforms. Additionally, there were more flake scars on the whole at LA 115260, another sign of more intensive reduction. At LA 115260, the greater emphasis on more intensive reduction may have involved a greater value placed on obtaining higher-quality lithic materials. For the most part, this pattern is evident. Chert, the highest quality lithic material available in any quantity in the area, is significantly more abundant at LA 115260, as are other fine-textured materials (even though silicified shale is the most abundant material on this site). LA 6829, on the other hand, contains more granite, igneous material, and quartzite, all materials of a more medium-grained texture. Although the most-common fine-grained texture material type for both sites is silicified shale, which is over-represented at LA 6829, it makes a poor candidate for intensive lithic reduction due to its tendency to fracture. If the silicified shale source is on or near LA 6829, then the distance of LA 115260 from LA 6829 might explain part of the difference.

In sum, there are significant differences in the lithic debitage assemblages between the two large Formative-period sites. These differences are small compared to the differences between the Archaic and the Formative, but appear to be indicative of subtle differences in flintknapping activities and raw material access between LA 6829 and LA 115260. While the lithic data alone cannot be used to address why there are differences between the two assemblages, the differences may have to do with the sites' locations vis-à-vis lithic source localities and perhaps also with the fact that the sites appear to be of slightly different temporal affiliation and exhibit different levels of occupational intensity (i.e., LA 115260 appears slightly earlier and is a smaller site than LA 6829).

### Comparison with NM 90

Based on the above analysis, there are significant differences between Formative-period sites in terms of their lithic assemblage, even though only a few kilometers separated these sites. A similar comparative analysis of Archaic sites was desired. However, in the project area only one of the Archaic components, LA 128699A, qualified for inclusion in such a comparative analysis (i.e., it was both dated to a sufficient degree of precision and could be cleanly segregated from the remains of a subsequent Formative-period occupation). For the other Archaic component, LA 128700A, the debitage assemblage was segregated from that of the Formative-period occupation at this site, but the Archaic component yielded only one radiocarbon date, and it is an extremely late date for the Late Archaic in this area (Beta-161823, two-sigma calibration A.D. 130–350). LA 128699A, on the other hand, is well dated to the early Late Archaic Fresnal phase, with 11 dates falling between 2480–1690 B.C. (based on two-sigma calibration ranges). Moreover, LA 128699A appears to have been a more intensive occupation than LA 128700A, given the large number of thermal features, along with a single preserved pit structure, at the former site. At the only other sites with chronometrically dated Archaic remains, LA 115262 and LA 128708, the lithic assemblages were thoroughly mixed with those of subsequent Formative-period occupations.

Because no more than one Archaic assemblage from the US 54 qualified for detailed, inter-site comparative analysis, this assemblage (LA 128699A) was compared to the debitage from the Wood Canyon Site (LA 99631), a substantial Late Archaic pithouse village located in the Big Burro Mountains of southwestern New Mexico (Van Hoose 2000). The Wood Canyon contains two Late Archaic components, one dating ca. 800–700 B.C. and the other ca. A.D. 60–120. As such, the Wood Canyon components date from a time frame later than that of the Late Archaic occupation at LA 128699. Moreover, Wood Canyon is located in a different environment, with specific lithic sources different from those found in the US 54 assemblages. Nevertheless, given that both assemblages from Wood Canyon also fall within the Late Archaic time frame, and had been subjected to a similarly rigorous debitage analysis (conducted by one of the lithic analysts involved in the US 54 project and involving essentially the same measures and variables), they were considered appropriate candidates for comparison with LA 128699A. For this analysis, the two assemblages from Wood Canyon are combined.

As with the comparative analysis of the two Formative-period sites, presented above, a standard statistical analysis was conducted for the Archaic assemblages included here. In Table 21.21, the results of a chi-square analysis of ten variables between the two sites suggest that they share a similar lithic signature. Six of the 10 variables analyzed are not significantly different between the two sites. The variable that reveals the most significant differences is material type, which can be expected between two geographically distinct regions. The other variables that are different between the two sites are exterior cortex, platform type, and thickness, all variables that are related to one another. Following is an examination of the significant variables and a discussion of the results.

There are statistically significant differences in maximum flake thickness between the two sites ($\chi^2$=39.3, p<0.001). Figure 21.34 presents a plot of the adjusted chi-square residuals of maximum flake thickness (in mm) between the two Late Archaic sites. Overall, flakes from Wood Canyon are thinner than those from LA 128699A; Wood Canyon includes more flakes than expected in the 1-mm interval than does LA 128699A, while the latter site contains slightly more flakes than expected in the 6–9 mm thickness interval. The other size intervals are not significantly different between the two assemblages. The average flake thickness at LA 128699A is 3.70, with a standard deviation of 3.02 mm. Wood Canyon flakes are slightly thinner on average with 3.15 mm in maximum thickness with a standard deviation of



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**Table 21.21 Comparison of LA 128699A and LA 99631 (Large Late Archaic Period Sites)**

| Variable | Chi-square Value | Probability | Significant Results |
|---|---|---|---|
| Length | 8.5 | p=0.075 | No difference |
| Thickness | 39.3 | p<0.001 | 128699A thicker flakes |
| Weight | 4.9 | p=0.551 | No difference |
| Material Type | 574.6 | p<0.001 | 128699A more chert, limestone, silicified shale |
| Material Texture | 1.8 | p=0.400 | No difference |
| Completeness | 6.6 | p=0.087 | No difference |
| Platform Type | 33.3 | p<0.001 | 128699A more unifaceted, fewer collapsed/multifaceted |
| Platform Cortex | 3.8 | p=0.052 | No difference |
| Cortex | 37.5 | p<0.001 | 128699A more exterior cortex |
| Edge Modification | 3.2 | p=0.073 | No difference |

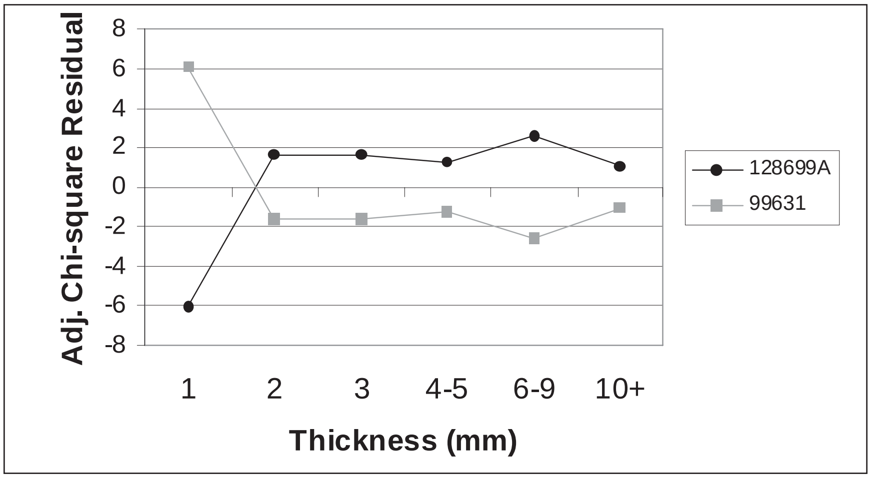


**Figure 21.34 Adjusted chi-square residuals on flake thickness between LA 128699A and LA 99631, two Late Archaic lithic assemblages.**

2.97 mm. The average and standard deviation of thickness for both sites are relatively similar, and really only differ in terms of the thinnest flake size interval. Because there are no significant differences in flake length or weight between the two sites, in general it can be argued that flake size overall is not significantly different. As will be discussed below, slightly thicker flakes at LA 128699A are probably the result of relatively more cortical flake reduction.

There are highly significant differences in grouped material types between the two sites ($\chi^2$=574.6, p<0.001). Figure 21.35 presents a plot of the adjusted chi-square residuals for material type between the two Late Archaic sites. LA 128699A contains significantly more chert, limestone, and silicified shale compared with Wood Canyon, which contains more igneous rock, obsidian, and rhyolite. As compared to the Formative-period assemblages, both Late Archaic sites indicate a focus on high-quality lithic materials. LA 128699A contains up to 15 percent low-quality lithic material (silicified shale and limestone), probably a result of its location in the resource-poor study area. Wood Canyon, on the other hand, is in a more advantageous location for lithic procurement, as evidenced especially by the relatively high frequency (7.7 percent) of obsidian in the assemblage. In sum, although there are differences in material type between the two sites, these differences are in material quality, suggesting that any relatively local material was acceptable as long as it was of high quality. The fact



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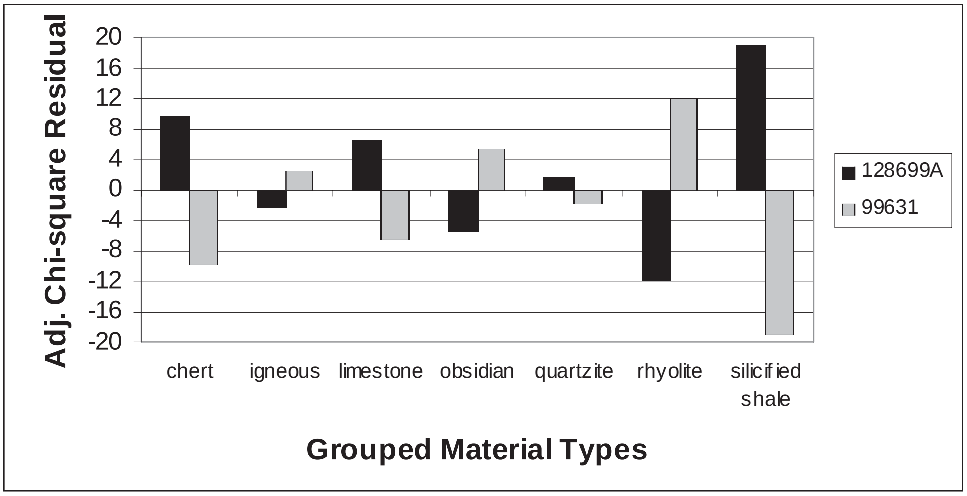


**Figure 21.35 Adjusted chi-square residuals on material type between LA 128699A and LA 99631, two Late Archaic lithic assemblages.**

that there was no significant difference in material texture between the two sites supports these conclusions.

There are statistically significant differences in striking platform type between the two sites ($\chi^2$=33.3, p<0.001). Figure 21.36 presents a plot of the adjusted chi-square residuals of striking platform type between the two Late Archaic sites. LA 128699A contains significantly more unifaceted platforms compared to Wood Canyon, which contains more collapsed and multifaceted platforms. The fact that flakes from LA 128699A contain more cortex, as discussed below, and have significantly fewer very thin (1-mm thick) flakes might explain this deviation.

There are statistically significant differences in exterior cortex between the two sites ($\chi^2$=37.5, p<0.001). Figure 21.37 presents a plot of the adjusted chi-square residuals of cortex between the two Late Archaic sites. LA 128699A contains significantly more flakes with cortex as compared with Wood Canyon. Platform cortex is almost

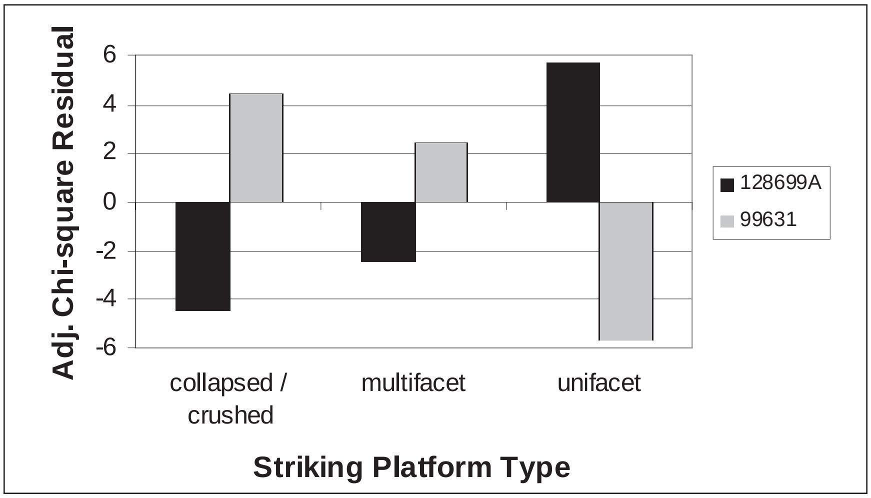


**Figure 21.36 Adjusted chi-square residuals on striking platform type between LA 128699A and LA 99631, two Late Archaic lithic assemblages.**



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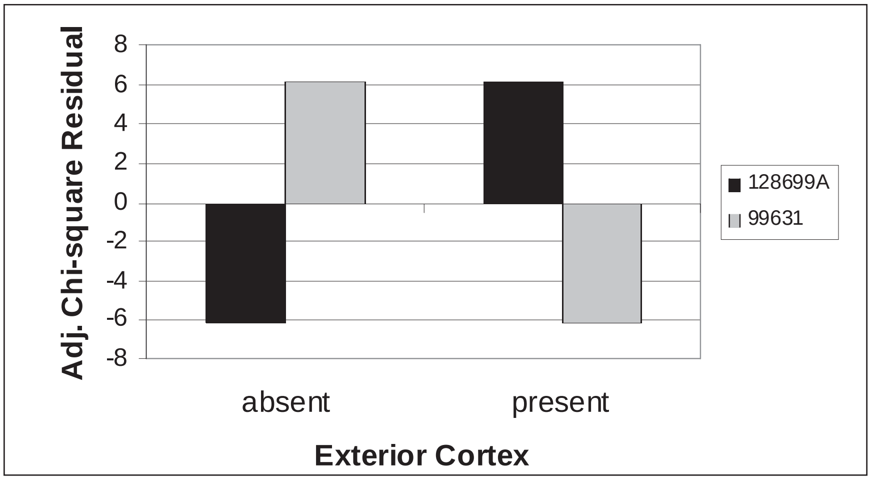


**Figure 21.37 Adjusted chi-square residuals on exterior cortex between LA 128699A and LA 99631, two Late Archaic lithic assemblages.**

significantly different between the two sites ($\chi^2$=3.8, p=0.052). Together, the data point to LA 128699A containing more initial stage reduction of materials than Wood Canyon.

In comparing the two Archaic sites, it is apparent that they share more similarities than differences. This result was somewhat surprising, as the two sites are geographically separate, especially when compared to the closeness of the two US 54 Formative-period assemblages, discussed above, which show more statistically significant differences in their debitage signatures. One of the main differences between the Archaic sites is in material type, which is to be expected from sites located in different geographical areas. Despite the difference in the specific raw material used, the apparent general characteristic of the raw materials selected was for high-quality, as is evidenced by the uniform (and statistically indistinguishable) reliance at both sites on fine-grained materials, mostly chert and rhyolite. This is in contrast to the Formative-period sites, where material quality was not as important a factor as material availability. Because so many of the lithic measures between LA 128699A and Wood Canyon were statistically indistinguishable (e.g., length, weight, completeness, and texture), it lends support to the conclusion that during the Archaic, a more standardized way of reducing lithics was in place as compared to the Formative period. During the Archaic period, the reliance on lithics was much greater than during the Formative period and the focus was on biface manufacture. This probably resulted in more standardized lithic assemblages, even across relatively great distances. During the Formative period, a decreased emphasis on the production and use of chipped stone tools and the more expedient flake technology probably led to more variation in flintknapping techniques and perhaps more varied adaptation of lithic technologies to local sources. In Formative times, the goal of most flintknapping was to produce usable flakes from lithic sources close at hand, regardless of material quality. Preform and biface production were deemphasized and what bifaces were produced consisted primarily of small arrow points produced from flakes, as opposed to the Archaic practice of producing larger projectile points (spear and dart tips) fabricated through multi-stage bifacial reduction. This may explain how two Formative-period sites (LA 6829 and LA 115260), located only a few kilometers apart, exhibit more differences in their debitage signatures than do two Late Archaic assemblages from sites separated by almost 250 km.

### Debitage Conclusions

The abundant debitage data from the US 54 project suggest several important lessons for lithic



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analysis methods in general and reveal several distinct trends in chipped stone technologies in the area across both time and space. The arguments and conclusions presented here are summarized as follows. First, when conducting a large-scale project where statistics are to be used in characterizing the lithic assemblage, sampling is recommended. Whether 1,000 or 5,000 flakes are individually analyzed, percentages will not change, given a valid sampling procedure. Accordingly, time invested in the analysis of flake numbers in excess of a few thousand would constitute a wasted effort with no additional gain in data. For this reason, a controlled sampling strategy was undertaken at LA 6829. Since all other sites contained relatively small lithic assemblages, they were analyzed in full.

Second, this study demonstrates the importance of conducting an interobserver error study when using more than one lithic analyst. By implementing such a control, we were able to identify potential problems with the data and successfully resolved those problems so that they were no longer an issue. Comparable data is of crucial importance, as shown in the final analysis of the Late Archaic sites from two different projects conducted. With comparable data and controlled interobserver errors, the data set for archaeological projects can be easily expanded from a project-specific study to regional and even supra-regional levels. One advantage a large company like TRC can offer is the ability to continue the development of a standardized database for lithic analyses with results that can be used to address much broader questions than those targeted by a single-project study.

Third, an extensive analysis indicates significant differences between surface and subsurface debitage assemblages. Surface artifacts are biased towards larger, more complete flakes and have a general tendency to be more characteristic of expedient-tool and/or core reduction than subsurface artifact. This may be due, in part, to the differential vertical movement of large and small flakes within a site (i.e., smaller flakes will migrate downward faster than larger flakes and thus tend to "disappear" more rapidly from the surface). It is argued here, however, that another—and perhaps more important—factor relates to variable recovery resulting from surface collection as opposed to screening of subsurface deposits. With screening, flakes tend to be collected with minimal bias, whereas standard surface collection methods probably result in a bias toward the recovery of larger, more complete flakes. When these two factors are combined, the potential for statistically significant differences between surface-subsurface debitage assemblages clearly emerges. Accordingly, surface and subsurface artifacts should be treated differently in terms of data analysis. In light of the findings of this study, most surface survey assemblages probably include a bias toward earlier stage reduction, which would affect survey results and, probably, interpretations. Controlled excavation is essential to accurately characterize a site's lithic assemblage.

Fourth, as this chapter shows, a spatial analysis of surface artifacts, combined with knowledge of the spatial distribution of temporally diagnostic features, can allow for the separation of Archaic and Formative components at some sites. In many reports, authors recognize the potential for multi-components within a site. Because there may be important differences between lithic assemblages based on size or time period, in doing lithic analysis it is essential to separate out those components to the extent possible and to treat multi-component assemblages that cannot be segregated as *mixed*. By separating out the components, in this study it was possible to determine that during the Formative period, lithic materials of high quality were desired, but not enough to travel any appreciable distances for them (and territorial circumscription in later periods may have restricted access to nonlocal lithic sources). This argument is supported by the apparent recycling of high-quality lithic debris by Formative peoples inhabiting sites previously occupied by Archaic peoples and the severe lack of high-quality lithic materials at Formative sites without Archaic components.



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Finally, the comparison of lithic assemblages between sites of similar size and temporal affiliation showed that during the Archaic-period, lithic technologies and assemblages were largely standardized, even between sites hundreds of kilometers apart. In the Formative period, on the other hand, lithic assemblages and technologies were more variable, sometimes even between two sites located near each other, but with different access to source materials. As mentioned above, the detailed comparison of Archaic assemblages from two geographically disparate sites investigated by two different projects was made possible by the application of comparably rigorous methods, in this case involving one analyst who analyzed both assemblages. Such analytical commitment and ease of database generation and use is made possible by large cultural resources operations, such as TRC, who have the capability to perform and commit staff to multiple large-scale projects.

In terms of the Formative-period sites, this study shows that detailed attribute analysis (even using expedient-technology, Formative-period lithics) can be useful for distinguishing between different behavioral signatures between sites. Results that simply list lithic counts and percentages would conclude that the two sites, LA 6829 and LA 115260, were basically the same. They both contain high percentages of silicified shale and otherwise look similar in their superficial characteristics. By using a standardized technique for defining flake variables (such as Sullivan and Rozen 1985) and examining multiple explicit variables (including both nominal and ordinal ones) with the aid of statistical methods, it was shown that these two sites are quite distinct in their lithic assemblages. Such a rigorous, detailed analysis can produce more in-depth and interesting results, allow more penetrating insights into prehistoric lithic technologies through time and space, and recognize levels of diversity that would not emerge through more simple approaches to lithic analysis.

## Ground Stone Artifacts

This analysis of grinding implements focuses on the information this artifact class can provide on prehistoric subsistence and food processing. As tools for processing food, manos and metates are an important component of subsistence technology. Some investigators have related changes in mano and metate form to changes in the relative reliance on cultigens, particularly the increasing intensity of procurement and utilization of seed foods (Hard 1990; Lancaster 1983, 1984; Mauldin 1993). An increase in reliance on agricultural foods presumably is tied to an increase in *per capita* cultigen production requirements (increased production of agricultural foods). This increased volume of cultigens may then accompany changes in grinding technology in order to increase the efficiency and intensity of seed processing. Processing effectiveness may increase in more than one way: increasing the volume of food processed per unit of energy or time expended and increasing the motor efficiency of the movements executed by the person who does the grinding, allowing for extended grinding sessions and the allotment of more time overall to grinding tasks (cf. Adams 1993, 1999; Wright 1990, 1993). Changes in processing efficiency are thus expected to encompass changes in both artifact form (e.g., increased mano surface area) and preferred motor skills and organization of movement during the grinding process. With sites spanning the Late Archaic to Late Formative periods, the US 54 ground stone assemblages can offer a view of changing food processing techniques, efficiency, and organization in a context of increasing dependence on cultigens. No evidence was found for maize exploitation at the Late Archaic components at US 54 sites, and Late Archaic ground stone technology has generally been interpreted as focused on processing wild grasses and annuals (Carmichael 1986). Nonetheless, maize cultivation was becoming part of the subsistence strategy reported during the Late Archaic (Carmichael 1986:213; Acklen *et al.* 1999), so the possible inclusion of maize processing in Late Archaic grinding activities at these sites cannot be ruled out.

Several researchers have proposed that mano size is a useful indicator of the degree of agricultural dependence (Hard 1990; Lancaster 1983, 1984; Mauldin 1993), arguing that an increase in the grinding surface of manos reflects an increase in efficiency of seed processing. Noting the fact that the variation in tool morphology visible to archaeologists results from a combination of intentional tool design and use modification (including grinding wear), Adams (1993, 1999) and Wright (1993) see ground stone morphology as primarily indicative of processing strategy rather than overall agricultural reliance (Adams 1993:491). This analysis will examine variation in attributes relevant to addressing both overall grinding efficiency and changes in the organization and time allotment of grinding activities.

An additional research issue relates to ground stone material preferences through time. In Carmichael's (1986) report on the large survey of the Tularosa Basin, he notices an apparent relationship between certain cross-sectional mano forms (wedge-shaped manos) and the use of sandstone (Carmichael 1986:191–201). In addition, he notices a greater proportion of sandstone artifacts on Archaic sites. This would suggest the possibility that wedge-shaped forms should also be more prevalent on Archaic sites. While the US 54 mano sample is small, the following analysis examines these patterns in the US 54 assemblages.

## ***Analytical Methods***

Because both manos and metates are artifacts that encompass both initial tool design and subsequent use-related modification, more than one scale of analysis was employed: both artifact-scale data and grinding surface-scale data were collected. While manos and metates are individual artifacts, any given artifact may exhibit more than one grinding surface, each representing an individual use context, because only one surface may be in use at a time. Further, the individual grinding surfaces on a single artifact often differ in important respects, requiring individual attention below the scale of single artifact. Due to these considerations, data on overall tool morphology and individual grinding surface attributes were recorded and kept in separate but linked tables within a relational database. A detailed discussion of data collection methods follows.

### Data Collection

While the vast majority of ground stone items are manos, metates, or grinding slabs, a few additional ground or abraded stone artifact classes were observed. These include polishing stones and a ground stone axe head. The polishing stones were considered handstones for the purposes of this analysis and underwent the same data collection. The axe head was analyzed as its own artifact class, recording length, width, and thickness to the nearest millimeter; weight to the nearest tenth of a gram; material type; and completeness. In addition, notes were taken regarding overall morphology.

#### *Artifact-Scale Data*

**Manos/Handstones**

Artifacts identified as manos and handstones were classified as such according to overall shape, size suitable for holding in the hand, and convex grinding surfaces usually characteristic of hand-held grinding stones. These are characterized by grinding surfaces ranging from convex to almost flat; concave surfaces are very rare in manos and handstones. All artifacts were measured with calipers to the nearest millimeter to determine length, width, and maximum thickness; only intact dimensions were recorded. In addition, all pieces were weighed to the nearest tenth of a gram using an electronic balance. Other variables included completeness (broken, whole), degree of intentional shaping (none, slight, moderate, heavy), and number of grinding surfaces.

The following additional attributes were recorded for handstones:

- **Type of handstone.** Options include mano (hand-held stone, usually fist-size or larger, showing evidence of significant grinding against another rock), polishing stone (usually smaller than a mano, showing high luster characteristic of polishing activities), and



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abrader (also smaller than a mano, exhibiting abrasion not necessarily characteristic of grinding against another rock).

- **Plan-view shape.** Options include ovate (relatively symmetrical manos with a recognizable long axis), subrectangular (highly symmetrical, with four highly rounded corners), rectangular (highly symmetrical, with four slightly rounded corners), irregular (usually generally ovate, but lacking symmetry), and unknown (used for pieces too fragmentary to determine original shape).

- **Cross-sectional shape.** This describes the orientation of faces relative to one another and is relevant both to grinding practices (Adams 1999) and temporal affiliation in the Tularosa Basin (Carmichael 1986). Options include uniface (one grinding surface, with relatively flat overall shape), parallel faces (cross-section shows two parallel faces), wedge (faces oriented at a marked angle to one another, often intersecting in a "pointed" profile), and triangular (usually three grinding faces oriented at pronounced angles to one another).

**Metates/Grinding Slabs**
Grinding slabs and metates are larger than handstones/manos and are the artifact that is held stationery during grinding with a handstone. Artifacts were classified as metates or grinding slabs if they showed a flat to concave grinding surface characteristic of grinding against another stone. Most metates were highly fragmentary, but measurements were taken to the nearest millimeter on the following dimensions, if intact: length, width, and maximum thickness (i.e., the total thickness of the slab). This analysis divides grinding slabs into the following broad categories:

- **Metates.** These are large grinding stones used with manos for large-scale or intensive grinding purposes, usually involving processing seed foods. These are further divided into the following types:

    - **Basin metates.** These have markedly concave grinding surfaces; they are usually made on minimally prepared slabs.

    - **Slab metates.** These are minimally prepared slabs with relatively flat grinding surfaces; sometimes referred to as "flat metates." These are equivalent to Adams's (1999) "flat/concave metates," which are metates that begin as flat slabs but gradually acquire concave grinding surfaces through extensive use. These are contrasted with the deep concavity characteristic of basin metates.

- **Netherstones.** These are smaller than metates, relatively thin slabs (less than 20 mm) that may not have been involved in seed processing, but may instead relate to grinding substances such as pigments and salt.

- **Palettes.** This designation is subtly distinct from netherstone, being more formalized and with a highly ground surface. This label was used for a single artifact from LA 6829.

**Unidentified Ground stone**
Many pieces of ground stone could not be assigned to any more specific artifact class because of their extremely fragmentary nature. These artifacts were still analyzed, recording the following data: material type, completeness (all "low," or less than 30 percent), and weight to the nearest tenth of a gram. Length, width, and thickness were recorded to the nearest millimeter in rare instances when any of these dimensions were intact.

**Grinding Surface**
Every ground stone artifact has one or more ground surfaces, many attributes of which can be assessed even on highly fragmentary pieces. Each separate grinding surface was examined and recorded individually. Attributes recorded are:

- **Grinding surface curvature.** This includes the following: flat (no noticeable curvature); uniaxially concave (concave relative to a single axis, but flat relative to the perpendicular axis); biaxially concave (concave relative to two perpendicular axes); uniaxially convex (convex relative to a single axis, but flat relative to the perpendicular axis); biaxially convex (convex relative to two perpendicular

axes); irregular (no clear convexity or concavity, but not flat; in other words, undulating); and unknown. Surfaces could also be coded simply as convex or concave if fragmentation made it difficult to determine curvature on more than one axis.

- **Pecking.** Grinding surfaces lose grinding efficiency as they become increasingly smooth, and may be rejuvenated by pecking to reroughen these surfaces. The presence or absence of pecking on the surface was noted.

- **Striation directionality.** Grinding surface striations will vary with grinding movements. Striation options include straight (unidirectional) and multidirectional.

#### *Treatment of Data*

Because all but a few of the grinding implements recovered were fragmentary, most assemblage-scale analysis of ground stone herein is based on weight data rather than artifact counts. Using counts only would result in overrepresentation of fragmentary pieces (e.g., three pieces of a single artifact might be counted individually, resulting in threefold overrepresentation of this artifact in the analysis).

#### A Note on Multicomponent Sites

Unlike the chipped stone artifacts, ground stone artifacts showed no intrasite spatial patterning in either artifact class or material type at multicomponent sites LA 128699 and LA 128700. For this reason, these ground stone assemblages will be classified as "Mixed Archaic" rather than split into "Archaic" and "Formative." The large majority of ground stone artifacts from both of these sites were recovered from portions identified as "Archaic" according to the chipped stone distribution. Assemblages with this designation discussed in this portion of the analysis should be understood to include Archaic components.

## *Individual Artifacts*

#### Axe

An item recovered from LA 6829 is interpreted as an axe; it is sandstone, with two surfaces (one flat, one convex) ground to form an acute angle in cross-section. A possible hafting groove extends across the back of the axe, oriented perpendicular to the plane of the artifact. The axe's working edge shows strong reworking, creating a retouched edge at approximately 45 degrees to the artifact's long axis. This edge shows battering use-wear. The expedient nature of the retouch and the overall asymmetry of the artifact suggest that it may be a recycled fragment of a milling implement. In addition, while the artifact clearly shows an apparent hafting groove and evidence of battering along a use edge, it is difficult to envision how this artifact would have been hafted. See Figure 21.38.

## *Grinding Implement Morphology*

#### Indeterminate Ground stone

Eighty-five pieces of ground stone were recovered that were too fragmentary to assign to a specific artifact type; these were classified as "indeterminate ground stone" (Table 21.22). The majority of these pieces at LA 6829 were granite (n=20), while most of the indeterminate pieces at LA 128699 and LA 128700 were sandstone (n=20 and n=5, respectively).

#### Manos and Handstones

"Handstone" was used as a generic term for any ground artifact or grinding implement that was likely held in the hand and ground against another object during use; manos were the most common handstone type identified. Table 21.23 presents counts of all handstone types recovered from US 54 sites. It is also likely that a large number of "unknown handstones" were also manos, but these were too fragmentary to determine overall morphology.

#### *Non-Mano Handstones*

A single artifact identified as an abrader was recovered from LA 6829. This object is limestone, which is a very soft rock and easily weathered. It shows evidence of abrasion or grinding wear on one surface, and its use is unknown. In addition, one polishing stone was recovered from LA 6829. This artifact is a chert pebble with polishing wear on part of its surface and may have been used in pottery production.

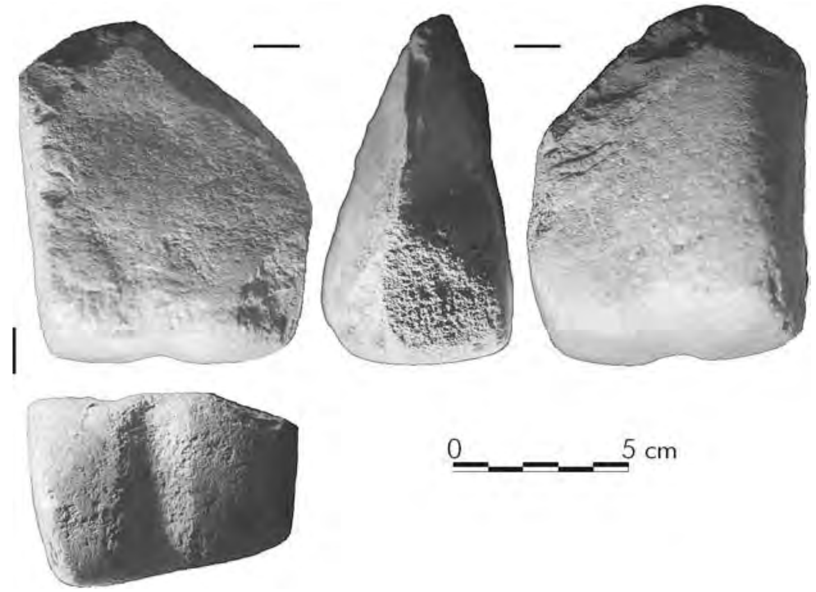


**Figure 21.38** **Four views of a possible ground stone axe from LA 6829 (PNUM 1256), showing both ground faces, a wedge-shaped cross-section, and possible hafting groove.**

**Table 21.22 Counts of Ground Stone Artifacts of Indeterminate Type, by Material**

| Site | Granite | Igneous | Limestone | Sandstone | Silicified Shale | Slate | Total |
|---|---|---|---|---|---|---|---|
| 6829 | 20 | 4 | 10 | 9 | 2 | 1 | 46 |
| 115260 | | | | 1 | | | 1 |
| 115262 | 1 | | | 1 | | | 2 |
| 128699 | 2 | 1 | 1 | 20 | | | 24 |
| 128700 | 4 | 1 | | 5 | | | 10 |
| 128708 | 1 | | | 1 | | | 2 |
| *Total* | *28* | *6* | *11* | *37* | *2* | *1* | *85* |

**Table 21.23 Manos and Other Handstones Collected from US 54 Sites**

| Site | Abrader | Mano | Other | Polishing stone | Two-hand mano | Unknown handstone | Total |
|---|---|---|---|---|---|---|---|
| 6829 | 1 | 52 | 1 | 1 | 1 | 9 | 65 |
| 115255 | | 1 | | | | | 1 |
| 115259 | | 1 | | | | | 1 |
| 115260 | | 1 | | | | 1 | 2 |
| 115262 | | 4 | | | | 1 | 5 |
| 115263 | | 1 | | | | | 1 |
| 115265 | | 3 | | | | | 3 |
| 128699 | | 9 | 1 | | | 1 | 11 |
| 128700 | | 4 | | | | 1 | 5 |
| *Total* | *1* | *76* | *2* | *1* | *1* | *13* | *94* |

Two items were classified as “other.” These artifacts were of unknown use, but were clearly not manos; one was a small piece of tabular sandstone shaped by flaking, with a ground surface; the other is a thin, tabular piece of limestone with heavy striations on one face.

***Mano Size***

Archaeologists often divide manos into two broad size categories: “one-hand” and “two-hand” manos. One-hand manos are those of a size suitable for easy use with one hand, while two-hand manos imply the use of both hands. This distinc-



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tion is an oversimplification that should not imply functional differentiation; for instance, "one-hand" manos can often be used with both hands by placing one on top of the other (Adams 1999:476).

All but two of the manos recovered were within the size range typical of "one-hand" manos (Figure 21.39). Two "two-hand manos" are rare in the US 54 assemblage, and only one of them is complete (Figure 21.40). This is a highly prepared mano that is long enough for two hands to be placed side-by-side on the implement. The other is only half of a much larger two-hand mano that has been reworked and reused in its broken form. Two-hand manos of this type are typically associated with either wide, flat metates or prepared trough metates, which together provide an efficient grinding system by presenting a large surface area. In allowing both hands to be used together, this system lets the grinder to "put his/her back into" the task, distributing stress and pressure across both arms and shoulders. Kernels are crushed more quickly and thoroughly (Adams 1993). No corresponding trough metate was identified in the LA 6829 assemblage, but the large majority of metate surfaces at this site are flat and might have been used with such a mano. While manos of this type are typically used in a back-and-forth grinding motion perpendicular to the long axis of the piece, many striations on the complete two-hand mano are actually parallel to the mano's long axis, while some are perpendicular. This suggests a degree of reorientation of the piece during grinding rather than a single preferred grinding direction.

Some researchers have argued that small manos are more likely to be used for general-purpose grinding tasks involving both food and nonfood materials, while large manos are more indicative of dedicated grain processing. Lancaster's (1984) study of ground stone from the Mimbres area divides manos into two groups, labeled "Type I" and "Type II" based on a slight clustering of points on a length versus width scatterplot (Lancaster 1984:19). He notes a slight discontinuity between the Type I cluster, with length less than 150 mm and width less than 130 mm and the Type II cluster having lengths greater than 150 mm and widths greater than 130 mm. He further makes different functional interpretations for these groups, arguing that the Type I manos are more likely to be used for general-purpose grinding. Mauldin (1993) makes the same general argument on the grounds of both ethnographic analogy and experimental study.

Figure 21.41 shows a scatterplot of US 54 manos with intact length and width dimensions. As the scatterplot shows, the artifact from LA 6829 identified as a two-hand mano is in fact at one end of a relatively even range of sizes, with little apparent bimodality in size. The line indicates the boundary between Lancaster's "Type I" and "Type II" manos. Most of the US 54 manos are well within the Type I range, while a few overflow into the Type II range. While Lancaster's data do show a slight break between these types, the US 54 assemblages clearly show continuous variation across this boundary; there is little evidence here for any clear size-based division. The main difference between the "two-hand mano" and the others is its greater length; it should be noted, however, that this scatterplot contains only data from a relatively small sample of intact manos. If longer manos tend to break more easily, then they would be underrepresented in this graph and would obscure a possible bimodal size distribution.

In addition, Mauldin's ethnographic data show a clear distinction between maximum possible surface area (calculated based on the mano's length and width) of manos used for processing non-grain materials such as dried meat, chile, and salt, and those dedicated to grinding agricultural grain (Mauldin 1993:321). All general-purpose manos in his sample had maximum surface areas of less than 175 $cm^2$ (mean=71.5 $cm^2$), while dedicated grain-processing manos exceeded 175 $cm^2$ (mean=400.9 $cm^2$). By this method, all US 54 manos fall within the "general-purpose" category, with an average area of 97.4 $cm^2$. The maximum



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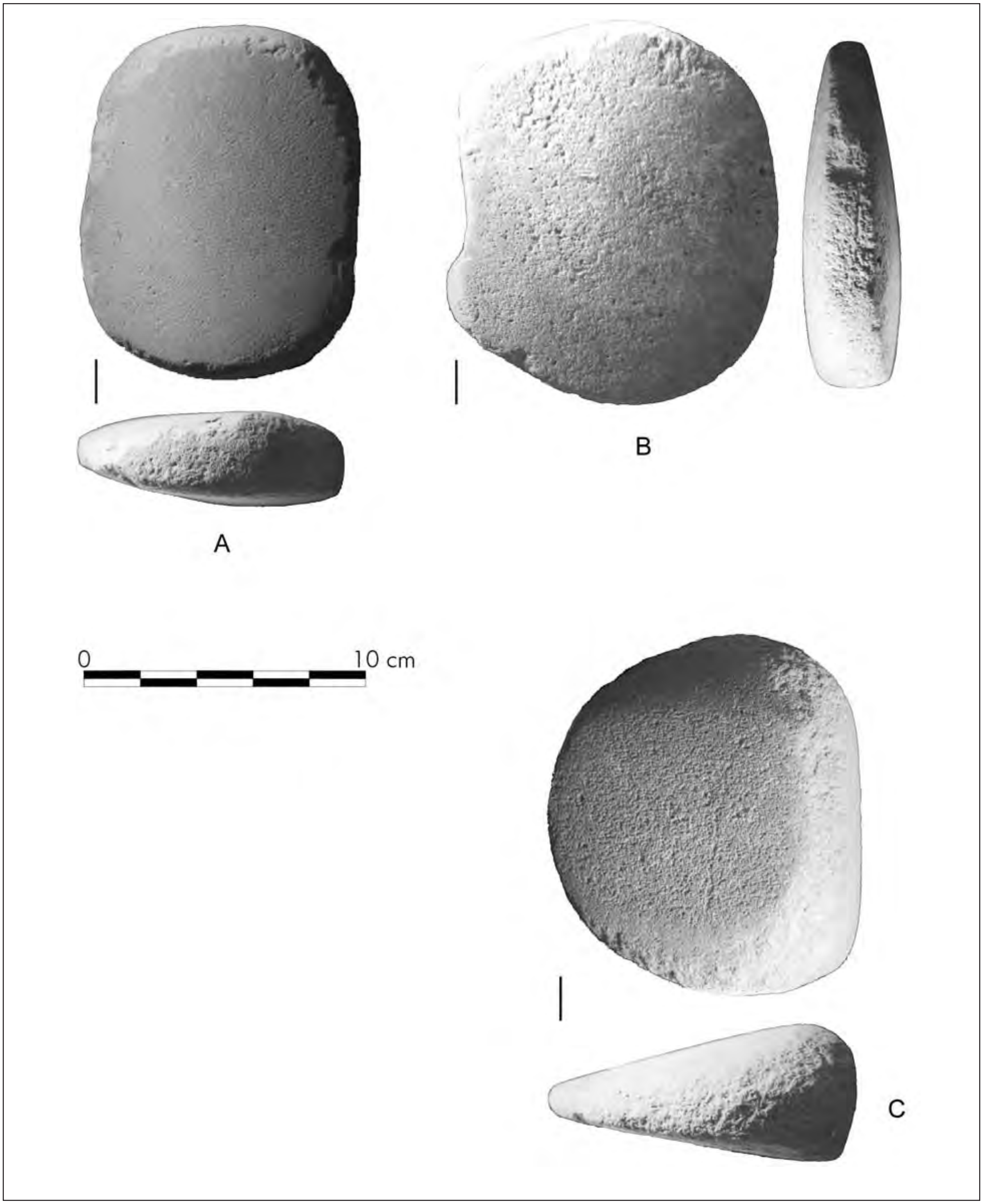


Figure 21.39 Three manos in the "one-hand" size range from LA 128699 (A. PNUM 472; B. PNUM 588; C. PNUM 474).



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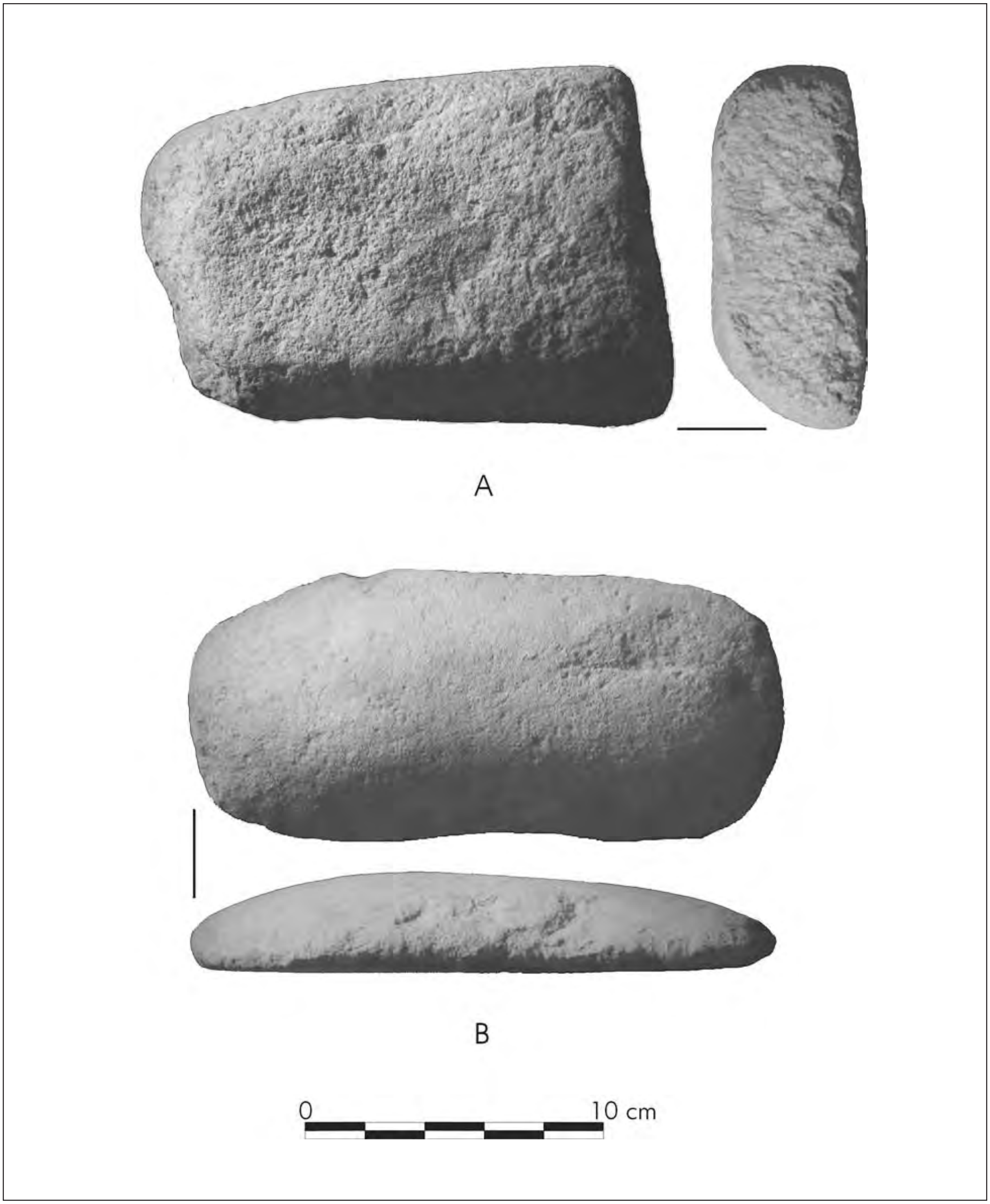


**Figure 21.40** **"Two-hand" manos recovered from LA 6829. A. large mano, broken in half (PNUM 1255); B. smaller intact mano (PNUM 888).**



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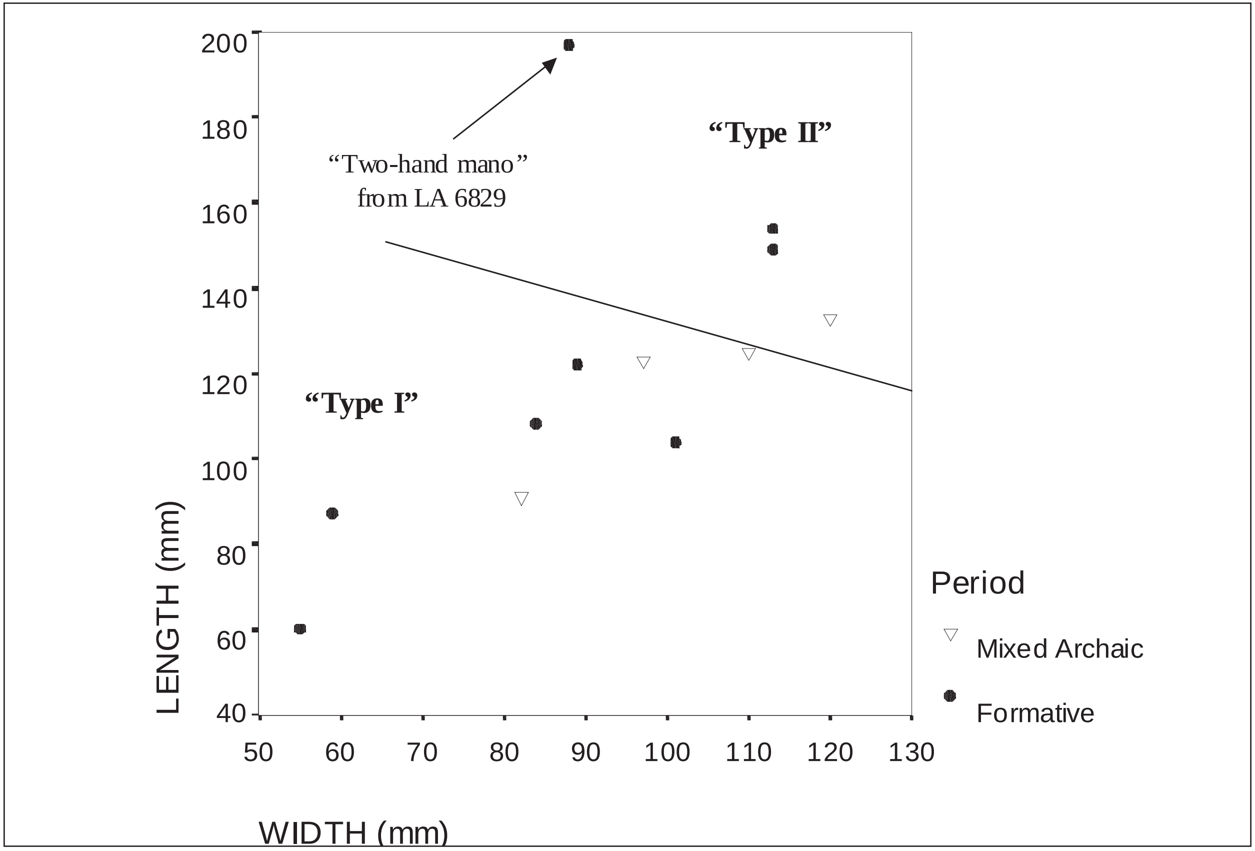


**Figure 21.41 Scatterplot of lengths and widths of intact US 54 manos. The size ranges characteristic of Lancaster's (1984) "Type I" and "Type II" manos are divided by a line.**

area is 174 $cm^2$, right at Mauldin's dividing line; this is a mano from LA 115265, a Formative assemblage; the "two-hand" mano from LA 6829 has an area of 173 $cm^2$. Descriptive statistics for manos are found in Table 21.24 (Mixed Archaic manos) and Table 21.25 (Formative manos). Means for all variables are similar between the two time periods, although the standard deviations for length and area are increased in the Formative assemblage by the inclusion of the "two-hand mano."

However, this does not mean that the US 54 mano assemblages were not used for processing agricultural grain. The modern ethnographic example represents a technology in which a formalized grain-processing system has developed within the larger grinding technology, creating a functional specialization. Before the advent of true two-hand manos, grain processing would have been carried out using smaller manos as well—whatever grinding technology existed would be used for seed processing before this functional differentiation occurred. It is important to recognize, however, that the manos analyzed here were likely

**Table 21.24 Descriptive Statistics for Mixed Archaic Manos (complete dimensions only)**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| **Length (mm)** | 4 | 91 | 133 | 118 | 18.5 |
| **Width (mm)** | 8 | 77 | 120 | 94.5 | 14.6 |
| **Thickness (mm)** | 8 | 23 | 74 | 44.9 | 16.9 |
| **Area (square cm)** | 4 | 74.6 | 159.6 | 122.8 | 36.1 |



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**Table 21.25 Descriptive Statistics for Formative Manos (complete dimensions only)**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Length (mm) | 8 | 55 | 197 | 122 | 44.1 |
| Width (mm) | 16 | 59 | 121 | 91.1 | 18.1 |
| Thickness (mm) | 24 | 23 | 82 | 41.1 | 13.6 |
| Area (square cm) | 8 | 33 | 174 | 113.1 | 55.1 |

used for multiple grinding tasks involving a variety of both cultivated and gathered food items as well as other nonconsumable materials.

***Mano Shape***

Mano shape was assessed in two ways: plan-view shape and cross-sectional shape. Table 21.26 shows the relative percentages, by weight, of various mano plan-view forms. This may suggest a possible greater representation of both irregular and rectangular mano forms in the Formative period, but this may simply be due to greater richness in the larger Formative sample (see discussion of the relationship between sample size and richness in the debitage section above). This is a very small sample, particularly for Mixed Archaic contexts (n=10).

**Table 21.26 Plan-View Mano Shapes, Excluding Unknowns, Scaled by Weight**

| Plan-View Shape | Mixed Archaic | Formative |
|---|---|---|
| Irregular | 51.19% | 76.89% |
| Ovate | 27.08% | 3.09% |
| Rectangular | 0.00% | 17.09% |
| Subrectangular | 21.73% | 2.94% |
| Total | 100.00% | 100.00% |
| | n=10 | n=35 |

The degree of intentional shaping evident in manos also appears to differ between Mixed Archaic and Formative assemblages, with Formative sites showing higher proportions of cobble manos (unshaped manos), manos with low degrees of shaping, and moderate degrees of shaping (Table 21.27). Mixed Archaic contexts overwhelmingly show high degrees of shaping. Again, few strong arguments can be made about this apparent difference without larger samples from Archaic contexts.

**Table 21.27 Degree of Intentional Shaping in Manos from Mixed Archaic and Formative Contexts, Scaled by Weight**

| Degree of shaping | Mixed Archaic | Formative |
|---|---|---|
| None (cobble mano) | 0.86% | 14.37% |
| Low | 23.54% | 37.77% |
| Moderate | 3.80% | 19.70% |
| High | 71.79% | 28.15% |
| Total | 100.00% | 100.00% |
| | n=14 | n=60 |

Mano cross-sectional shapes also show differences between periods. Table 21.28 shows that wedge forms dominate Mixed Archaic assemblages (60 percent by weight, versus only 20 percent at Formative contexts), while parallel faces are most common at Formative sites (50 percent by weight, versus only four percent Mixed Archaic).

**Table 21.28 Cross-Sectional Shapes Represented in US 54 Mano Assemblages, Scaled by Weight**

| Cross-sectional shape | Mixed Archaic | Formative |
|---|---|---|
| Irregular | 0.63% | 11.62% |
| Ovate | 16.30% | 0.00% |
| Parallel faces | 3.99% | 50.45% |
| Triangular | 0.00% | 2.96% |
| Wedge | 59.62% | 20.39% |
| Uniface | 19.45% | 14.58% |
| Total | 100.00% | 100.00% |
| | n=12 | n=40 |

Cross-sectional form can be interpreted in multiple ways. Adams (1993) indicates that wedge-shaped mano forms are created through long-term grinding with reciprocal strokes, that is, strokes moving back and forth along a single line, rather

than circular strokes. As the hand pushes down on the forward stroke, it puts a disproportionate amount of pressure on the proximal edge of the mano, resulting in increased wear on one side. Over time, this results in a wedge-shaped cross-section (Adams 1993:335). A wedge-shaped form can be avoided even with reciprocal strokes if the mano is often reoriented in order to distribute wear evenly on more than one edge. Given this, the manos in the Late Archaic contexts appear to represent a greater degree of unidirectional grinding without frequent reorientation of the mano, while Formative manos appear to represent either more circular or varied strokes, or more frequent reorientation of the artifact during grinding. The relationships between form and grinding techniques are discussed further in the section on grinding techniques below.

Also relevant to this discussion is the possibility that differences in material characteristics may affect this as well. Carmichael (1986:191–201) notices an apparent relationship between wedge-shaped manos and sandstone. Rather than attributing this to different stroke types, he posits a mano use-reduction sequence in which uniface forms give way to parallel-face (plano) forms, and after extensive use result in wedge-shaped and triangular forms. He does notice that forms in a more “advanced” state of wear according to this system disproportionately appear to be sandstone, while parallel-face manos tend to be granite. He thus argues that because sandstone is a more friable rock than granite, it is likely that manos of this material will be “used up” more quickly than granite manos and will thus disproportionately show wedge-shaped cross-sections. The US 54 assemblages show the same pattern; most of the US 54 wedge-shaped manos are sandstone (72 percent by weight), while most of the parallel-shaped manos are granite (85 percent by weight).

However, Carmichael also notes a possible preferential use of sandstone on Archaic sites, with granite dominating the assemblages of Formative sites, a pattern also borne out in the US 54 data. Sandstone makes up 66 percent of Mixed Archaic manos (by weight) versus 25 percent granite, while in Formative assemblages granite makes up 67 percent versus 27 percent sandstone. While he does not articulate this explicitly, this suggests that wedge-shaped forms may be more common on Archaic sites, indicating a possible temporal trend rather than simply a use-wear sequence. A reanalysis of the survey data provided in Carmichael’s Appendix F (Carmichael 1986:352–377) shows a possible relationship between time and mano form. Although not significant at the 0.05 level, a chi-square analysis of Carmichael’s survey data shows a possible positive association of wedge-shaped manos with the Archaic and Mesilla phases ($\chi^2$=2.95, significance level=0.086), which reflects the pattern seen in the US 54 assemblages. Because of the association of sandstone with the Archaic, wedge forms with the Archaic, and wedge forms with sandstone, it is difficult to establish which of these three factors drives the overall pattern. However, the (albeit weak) temporal associations of form and material provide a possible chronological indicator for ground stone–bearing sites in the region.

**Metates and Grinding Slab Morphology**

The US 54 project recovered 123 pieces of grinding slabs, most of which represent parts of metates (Table 21.29). The table reports two palette fragments; actually, one of these is a nearly complete palette in 38 pieces, all recovered from a single location, many of which refit; this is therefore coded as a single piece. The large majority of grinding slabs, or metates, are highly fragmentary, and only one intact metate was recovered from US 54 sites: a small slab metate only 23 x 15 cm with a flat to irregular grinding surface. As such, it is difficult to describe in detail the overall morphology of these metates. A small number of artifacts from sites LA 128699 and LA 6829 are complete enough to briefly describe overall forms. LA 128699, a primarily Late Archaic assemblage, shows small minimally prepared oval slabs with deeply concave basin-shaped grinding surfaces (Figure 21.42). The LA 6829 forms are also minimally shaped and prepared, but exhibit more flat grinding surface shapes similar to the artifact illustrated in Figure 21.43.

**Table 21.29 Metates and Other Grinding Stones Collected from US 54 Sites**

| Site | Basin metate | Flat metate | Slab metate | Metate | Netherstone | Pallette | Total |
|---|---|---|---|---|---|---|---|
| 6829 | 4 | | 11 | 13 | 12 | 1 | 41 |
| 115255 | | | | 3 | | | 3 |
| 115257 | | | | 3 | | | 3 |
| 115259 | | | | 1 | | | 1 |
| 115260 | | | | 3 | 2 | | 5 |
| 115262 | 1 | 1 | | 6 | 1 | | 9 |
| 115263 | | | | 1 | | | 1 |
| 115265 | | | | 1 | | | 1 |
| 128699 | 6 | 1 | 8 | 3 | 18 | | 36 |
| 128700 | | 4 | 1 | 8 | 7 | | 20 |
| 128708 | 1 | | 2 | | | | 3 |
| *Total* | *12* | *6* | *22* | *42* | *40* | *1* | *123* |

By proportional weight, slab metates dominate Formative metate assemblages (78 percent), with basin metates only accounting for five percent (Table 21.30). While slab metates are also the most prevalent form in Mixed Archaic assemblages, they make up only 41 percent versus 37 percent for basin metates.

**Table 21.30 Metate Forms by Period, Scaled by Weight.**

| Metate Type | Mixed Archaic | Formative |
|---|---|---|
| Basin metate | 37.19% | 5.31% |
| Flat metate | 6.63% | 0.00% |
| Slab metate | 41.31% | 78.46% |
| Metate | 14.87% | 16.23% |
| Total | 100.00% | 100.00% |
| | n=31 | n=33 |

As with manos, Mixed Archaic assemblages show a predominance of sandstone (59 percent by weight) over granite (38 percent), in contrast with the dominance of granite at Formative sites (59 percent by weight, versus only 12 percent for sandstone). Because of the incompleteness of most of these artifacts, more information about individual grinding surfaces was obtainable than of overall artifact morphology. Usually the only complete dimension for these artifacts was thickness; only maximum thickness (i.e., the total thickness of the slab) was recorded. Summary statistics for thickness for all main metate types are presented in Table 21.31, which show no appreciable differences in metate thickness according to metate type; in other words, metate slabs were usually approximately 35–40-mm thick regardless of type. When separated according to time period, there is a slight difference in thickness: Mixed Archaic metates average 32 millimeters, while Formative metates average 41 millimeters. Grinding surface configurations are discussed below in the section on grinding techniques represented in the US 54 assemblages.

**Table 21.31 Descriptive Statistics for Metate Thicknesses for All Metate Forms**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| **Basin metate** | 8 | 21 | 57 | 36.1 | 12.8 |
| **Slab metate** | 14 | 18 | 78 | 40.2 | 15.5 |
| **Metate, indeterminate** | 10 | 19 | 82 | 36.8 | 18.7 |

***Netherstones and Palette***

In addition to metates, several small fragments interpreted as netherstone fragments were recovered from five sites, spanning all time periods (see Table 21.29, above). All netherstone fragments were thin, tabular sandstone with flat grinding surfaces; thickness averages 10.1 mm, with standard deviation of 3.2 millimeters. These artifacts were likely used to grind non-seed materials such as pigments, other minerals, or salt. These are morphologically similar to a small sandstone


**Figure 21.42** **Basin-shaped metate forms. A. metate with two opposed grinding surfaces (LA 128699, PNUM 555); B. larger, more formally-prepared metate from LA 128708 (PNUM 85) with only a single grinding surface. While the grinding surfaces on both artifacts are biaxially concave, note the overall elongated form of the grinding surfaces. These are both consistent with unidirectional grinding strokes.**


**Figure 21.43 Flat-surface metate fragment. This artifact, from LA 128699 (PNUM 596), shows an edge prepared by flaking.**

artifact from the Turquoise Ridge site described by Whalen (1994b:111), measuring 12 x 8 cm, with a thickness of 1 cm. This flat-surfaced grinding slab (called a "palette" by Whalen) had yellow and red pigment residue still adhering to its surface.

Thirty-nine fragments of what is referred to here as a palette, or a very thin limestone artifact with an extremely smooth surface, were recovered from an extremely localized area at LA 6829. All pieces have an extremely uniform thickness of only 4 mm, and as such are likely pieces of a single artifact.

### *Grinding Techniques Represented in the US 54 Assemblages*

Adams (1993, 1999) argues that rather than being considered as different artifact classes, manos and metates are best understood as the two necessary and complementary elements of a dynamic unit. While we were unable to find any individual mano-metate sets that were demonstrably used together, patterns of overall artifact shape and individual grinding surface morphology provide evidence for how these artifacts were used together in general. Changes in mano and metate form must be understood in terms of changes in food processing strategy, motor habits, artifact design, and especially the organization of food processing tasks as well as food processing requirements.

Adams distinguishes grinding efficiency from grinding intensity in her discussion of the energetics of grinding tasks. Efficiency describes the amount of grain processed per unit of time, while intensity refers to the amount of time devoted to a grinding task itself. In other words, increased efficiency means that more food can be ground during an hour, while increased intensity means that more hours can be devoted to grinding tasks (Adams 1993:334). Adams also describes two general grinding stroke patterns: reciprocal strokes involve a back-and-forth motion, moving the mano along a single line; circular strokes involve moving the mano in rounded, circular patterns. These two stroke types have important implications for both the energetics of grinding tasks, as well as for the eventual forms of the artifacts and the configurations of their grinding surfaces. Either stroke type may be used with either basin or flat metate forms, although circular strokes are most common with basin forms.

Through experimental replication studies, Adams notes the following:

1. Basin metates are more tiring to use than are flat metates because they usually require all of the work of both controlling the direction of grinding and exerting downward pressure on the mano to be done by one arm. This may be ameliorated by frequent switching between left and right hands or by placing both hands concurrently on the mano. Because of the convex shape of the basin, this forces a shift in body posture to behind the metate, resulting in less pressure and slower strokes. Thus, grinding intensity may be lower due to shorter grinding sessions, or efficiency may decrease if both hands are used (Adams 1993:485)

2. Flat metates allow the use of a greater surface area by allowing the mano to move freely over the metate, and thus may enhance efficiency. In addition, grinding intensity may be

increased because this metate form allows both arms to be used concurrently by placing both hands side-by-side on the mano, thus distributing the work equally between them and allowing the grinder to use not only arm muscles, but the back, shoulders, and legs in the grinding work (Adams 1999:485).

3. Flat metates are more efficient at processing soaked maize kernels and oily seeds such as sunflower seeds, but less efficient at processing dry maize kernels or amaranth seeds than basin metates. This is because while basin forms may allow less grinding intensity, their concave surfaces keep the grain from escaping as the mano moves. Dry kernels against a flat metate are likely to be pushed over the edge, decreasing efficiency. Soaking kernels creates a stronger bond between food and stone, allowing the grinder to take advantage of the greater available grinding surface area.

With these observations in mind, the US 54 analysis sought to quantify variation in grinding surfaces that might indicate the kinds of grinding strokes used and the intensity of ground stone use. Curvature of grinding surfaces (see "grinding surface scale data" in "Data Collection" section above) reflects both the prevalence of reciprocal or circular grinding strokes, as well as the shape of the metate surface used for grinding. Manos used with circular strokes in basin metates will have grinding surfaces that are biaxially convex, because all edges of the mano are in contact with the basin at some point during the circular stroke. Manos used reciprocally in basin metates, however, will show predominantly uniaxial curvature because the greatest pressure is exerted only on the proximal and distal edges of the mano as it is moved forward and back; the lateral edges rarely bear the full brunt of grinding pressure. Flat mano surfaces reflect use on a flat metate and can represent either reciprocal or circular strokes.

Regarding metate curvatures, these also may vary depending on the kind of stroke used. Basin forms are defined solely on the basis of deep concavity. However, the nature of the concavity will vary with stroke type: circular strokes in a basin form will tend to produce and reinforce strong biaxial concavity, creating a crater-like grinding surface. Reciprocal strokes, however, will reinforce basin forms that have elongated, linear grinding depressions; depending on depth, these may be reflected in either uniaxial concavity or slight biaxial concavity.

Also useful for determining stroke type is the dominant directionality of striations present on grinding surfaces. Circular strokes will produce multidirectional or curved striations, while reciprocal strokes will tend to create linear, unidirectional striae.

### US 54 Mano Grinding Surfaces

Table 21.32 presents curvature data for mano grinding surfaces in the US 54 assemblages. Mixed Archaic sites show a greater degree of uniaxial convex surfaces, while Formative manos exhibit more biaxially convex surfaces. This suggests a greater degree of reciprocal grinding strokes in the Archaic, even in basin metate forms.

**Table 21.32 Mano Grinding Surface Curvature, by Period (Scaled by Weight)**

| Grinding Surface Curvature | Mixed Archaic | Formative |
|---|---|---|
| Uniaxial convex | 40.87% | 22.65% |
| Biaxial convex | 29.46% | 27.27% |
| Flat | 21.38% | 38.04% |
| Irregular | 8.30% | 11.18% |
| Total | 100.00% | 100.00% |
| | n=22 | n=91 |

This pattern is also seen in metate grinding surface curvature (Table 21.33). Biaxially concave grinding surfaces, or classic basin metate forms, dominate the Mixed Archaic assemblages, while flat or irregular/flat grinding surfaces dominate the Formative period. These irregular/flat surfaces are mostly flat, but show occasional undulations. A slight discontinuity appears between mano and metate grinding surfaces during the

Formative period; while most of the Formative metate surfaces are flat or nearly flat, a large proportion of the Formative mano surfaces (approximately 50 percent) are either uniaxially or biaxially convex.

**Table 21.33 Metate Grinding Surface Curvature, by Period (Scaled by Weight)**

| Grinding Surface Curvature | Mixed Archaic | Formative |
|---|---|---|
| Uniaxial concave | 5.19% | 8.41% |
| Biaxial concave | 69.78% | 6.77% |
| Flat | 25.02% | 13.72% |
| Irregular/Flat | 0.00% | 71.09% |
| Total | 100.00% | 100.00% |
| | n=32 | N=44 |

Directionality of striations on grinding surfaces also shows a slightly increased incidence of circular or nonreciprocal strokes during the Formative period. Metate data show that nearly all grinding striations are unidirectional (Table 21.34), while 12 percent of the Formative-period surfaces show multidirectional striations. This suggests circular strokes or a combination of circular and reciprocal strokes to a greater degree during the Formative period.

**Table 21.34 Directionality of Grinding Striations on Metates, by Period**

| Striation Directionality | Mixed Archaic | Formative |
|---|---|---|
| Multidirectional | 2.81% | 12.15% |
| Straight (unidirectional) | 97.19% | 87.85% |
| Total | 100.00% | 100.00% |
| | n=29 | n=31 |

Mano striation directionality shows almost the same percentages of multidirectional and unidirectional striations for each period (Table 21.35). While this supports the patterns noted in the metate data, the differences between periods may be largely due to this discrepancy in sample sizes between periods.

**Temporal Trends in Grinding Technology**

Taken together, the data presented on mano and metate materials, morphology, and grinding surface characteristics indicate the following temporal trends between the Late Archaic and Formative periods represented by the US 54 sites:

**Table 21.35 Directionality of Grinding Striations on Manos, by Period**

| Striation Directionality | Mixed Archaic | Formative |
|---|---|---|
| Multidirectional | 0.00% | 11.45% |
| Straight (unidirectional) | 100.00% | 88.55% |
| Total | 100.00% | 100.00% |
| | n=15 | n=63 |

- Ground stone material preferences shift from sandstone during the Archaic to granite during the Formative period. The reason for this is unclear, but may relate to Archaic mobility and availability of these materials or preferences for material textures.
- Basin metate forms give way to flat metate surfaces.
- While reciprocal grinding strokes dominate both time periods, the Formative sees an increase in the diversity of strokes possible, including circular strokes.

There is no increase in mano surface area noted in the assemblage of whole manos, but the presence of fragmentary manos at LA 6829 that were clearly much longer than those found in the Mixed Archaic assemblages suggests that mano surface area was increasing to take advantage of the greater surface area provided by flat metate forms.

Overall, these patterns suggest increases in both grinding efficiency and grinding intensity. Formative-period occupants were able to produce significantly more flour or meal *per capita* than their Late Archaic counterparts and were able to spend more time per grinding session as well. The increase in flat metate forms not only freed up a greater exploitable surface area for grinding, but also allowed a transformation of the grinding process from one dominated by slower, asymmetrical one-handed grinding to a more balanced application of force by both shoulders, as well as the back and legs. This shift allows not only



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longer grinding sessions due to less muscle fatigue, but the exertion of greater force per stroke as well. It is also important that this shift likely accompanied a shift from dry seed processing to soaked kernels and may even be associated with shifts in plant species or even corn varieties used. Adams (1999:479) indicates that the potential for reliance on flour-based recipes depends in part on the kinds of maize crops grown: pop and flint corn have hard endosperms and little soft tissue and do not yield much flour when ground. These are usually processed by soaking and mashing, or kernels are consumed whole. Flint corn or dent corn, on the other hand, have more soft floury tissue and produce much greater amounts of flour. As such, grinding becomes an important method of increasing the digestibility of these cultigens. Changes in grinding technology toward increased efficiency and longer grinding sessions is thus likely to reflect an increase in the importance of flour-based recipes and not necessarily an increase in the overall importance of corn or rate of seed and cultigen consumption.

## Other Stone: Beads, Pigments, and Minerals

Most of the artifacts described and analyzed in this chapter are utilitarian: tools and the products of tool manufacture. While quite rare relative to these artifact classes, several stone objects were recovered that are likely related to ornamental or other more esoteric uses (Table 21.36). These objects include both a shaped artifact (bead) and minerals likely used for pigments (referred to generically here as red and yellow ochre), as well as unmodified minerals (quartz crystals, biotite, and turquoise).

### *Stone Bead*

One stone bead and fifteen mineral samples were recovered from LA 6829. The bead is a cylindrical form with a drilled hole and is of a soft white carbonate rock (Figure 21.44). It effervesces with dilute hydrochloric acid, indicating a high carbonate content. While this rock does not resemble the typical limestones found in the assemblage, it

**Table 21.36 Other Stone Items Recovered from US 54 Sites**

| Site | Feature | Material | Weight (g) | Comments | PNUM |
|---|---|---|---|---|---|
| 6829 | 166 | “Red ochre” | 0.2 | Friable, small | 1649 |
| 6829 | 197 | “Red ochre” | 1.5 | Possible red ochre (pink; very friable, not worked) | 1845 |
| 6829 | None | “Yellow ochre” | 0.3 | Slightly ground | 1464 |
| 6829 | 147 | “Yellow ochre” | 0.4 | Ground | 1741 |
| 6829 | 54 | “Yellow ochre” | 1.3 | Unworked | 1331 |
| 6829 | 54 | “Yellow ochre” | 6 | Ground and faceted | 1122 |
| 6829 | None | Bead: probable calcite | 0.1 | Cylindrical stone bead | 796 |
| 6829 | None | Biotite | 1.4 | Dark mica, unworked | 1499 |
| 6829 | 17 | Quartz crystal | 0.1 | Euhedral; 11.0 x 2.5 mm | 49 |
| 6829 | None | Quartz crystal | 0.5 | Fragment; euhedral; 14.2 x 6.3 x 4.2 mm | 652 |
| 6829 | 79 | Quartz crystal | 0.7 | Fragment; euhedral; 14.5 x 7.4 x 4.8 mm | 1483 |
| 6829 | None | Quartz crystal | 3.5 | Euhedral; 22 x 14 x 10 mm | 78 |
| 6829 | None | Turquoise | 0.1 | Unworked, no matrix | 1455 |
| 6829 | None | Turquoise | 0.5 | Unworked, no matrix | 923 |
| 6829 | None | Turquoise | 0.6 | Unworked, minimal matrix | 917 |
| 6829 | None | Turquoise | 0.9 | Unworked, in matrix | 919 |
| 115260 | 1 | “Yellow ochre” | 1.8 | Ground, with striations | 156 |
| 115260 | 1 | Hematite | 0.1 | Hematite; ground and faceted | 259 |
| 115260 | 1 | Unknown pigment | 0.2 | Possible pigment; soft, waxy black rock; possible grinding | 250 |
| 128708 | 42.1 | “Red ochre” | 1.4 | Ground and faceted | 50 |

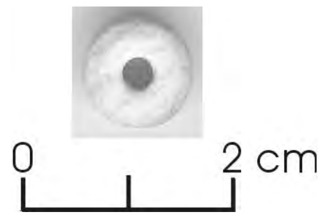


**Figure 21.44 Drilled stone bead (LA 6829, PNUM 796).**

is likely to be calcite. The carbonate bead is 5.9-mm thick with a diameter of 10.5 mm, and the drilled hole is 3.0 mm in diameter.

### *Possible Pigments*

Several pieces of a soft, friable, yellow-tan material were recovered from US 54 assemblages, many of them exhibiting facets indicating grinding. These were collected as "yellow ochre," and were likely used for some sort of pigment, possibly in pottery manufacture. All came from Formative assemblages. In addition, small pieces of material identified in the field as "red ochre" were collected. These are similar in texture to the "yellow ochre," soft and friable, and one piece showed clear faceting as well. A piece of hematite with grinding facets was also recovered. In addition, a soft, dark-colored rock with waxy luster also exhibited possible grinding facets. This rock was identified as a possible pigment.

### *Unmodified Minerals*

LA 6829 yielded four small well-developed euhedral quartz crystals, one chunk of unmodified biotite (dark mica), and four very small pieces of unworked turquoise, two of which retain some of the mineral's original monzonite rock matrix. All four quartz crystals are hexagonal prisms and two have intact pyramidal terminations at both ends. None show evidence of cultural modification. All of these minerals occur naturally in the Jarilla Mountains. See the section on lithic materials for further discussion of source areas.

## Summary and Conclusions

This analysis of chipped stone and ground stone artifacts addresses issues of chronology, technology, subsistence, and regional interaction set forth in the research design. While information provided by formal tools such as projectile points and bifaces is essential to an overall understanding of lithic technology, the approach taken in this lithic study has focused largely on the data potential for the most ubiquitous classes of lithic artifacts, drawing conclusions about behavior based on the cumulative information provided by debitage and small fragments of ground stone at the assemblage scale. Debitage analysis allows a large-scale assessment of overall lithic reduction modes without the need to rely on large samples of formal tools. Some previous ground stone studies conducted in the Tularosa Basin have been somewhat limited by the extremely fragmentary nature of the ground stone artifacts present at most of these sites (cf. Scarborough 2001; Whalen 1994b:112). This study attempts to maximize the amount of information that can be derived from these artifacts by gathering data beyond the level of individual whole artifact and focusing on individual grinding surfaces, which are present on all artifacts identified as ground stone.

The following conclusions are presented regarding the central research issues:

**Chronology.** Diagnostic projectile point types identified in US 54 lithic assemblages range from Archaic to Late Formative types, and are consistent with types described and reported from other projects conducted in the Tularosa Basin and surrounding areas. These points have wide reported date ranges, but the temporal parameters for these types are generally consistent with chronological data derived from other sources, such as radiocarbon dates and associated ceramics.

**Regional Interaction.** All lithic materials observed in the US 54 assemblages are available locally within the Tularosa Basin or the Rio Grande gravels. The presence of turquoise in

unworked form at LA 6829 suggests the possibility that this is a trade item or commodity for exchange. Church *et al.* (1996:127) indicate that the Jarilla turquoise source has even been linked prehistorically to trade at Casas Grandes.

**Technology and Subsistence.** The US 54 sites represent human occupation through the Late Archaic and Formative periods. This transition is marked by broad changes in subsistence, mobility, and resource exploitation strategies. Late Archaic occupations are characterized by wide exploitation of hunted and gathered foods accompanied by an ongoing process of decreasing mobility in comparison to earlier periods and an increase in the reliance on cultivated food products. The Formative period continues the trend of increased population size, sedentism and reliance on agriculture (Acklen *et al.* 1999:100–105). These regional trends are the context for the US 54 lithic assemblages.

Both chipped stone and ground stone data show dramatic technological shifts between the Late Archaic and Formative periods. These changes encompass differences in lithic material preferences and procurement, intensiveness of lithic reduction, and relative focus on formal tool production versus expedient core reduction. Late Archaic chipped stone assemblages at LA 128699 and LA 128700 follow the expected pattern of soft-hammer production of formal tools, while the Formative assemblages suggest more less formalized, hard-hammer reduction of cores. While few bifaces were recovered from US 54 sites, the overall lithic signature of the Late Archaic components is extremely similar to the Late Archaic Wood Canyon site excavated as part of the NM 90 project. Together, these assemblages point toward a lithic industry focused on intensive formal tool production, particularly of bifaces, as part of an overall strong Archaic reliance on chipped stone technology. Lithic tools played a more central role in pre-agricultural Archaic subsistence strategies than in the later Formative period, and involved greater investment of time and energy in production and maintenance of lithic tools; this resulted in a general uniformity of lithic assemblages over great distances.

The US 54 data also support previous observations about temporal trends in lithic material selection. With the exception of projectile points, all data show a shift in chipped stone material preferences. Late Archaic assemblages are characterized by a preference for high-quality materials including cherts and fine-grained rhyolites, while Formative assemblages are dominated by the poorer-quality but locally abundant silicified shale. The great reliance on chipped stone tools during the Archaic, combined with probable greater mobility, resulted in the procurement of finer material over greater distances.

Ground stone technology also shows changes during this time span, and the US 54 data generally agree with previously recognized trends. Carmichael (1986) notes a change in preferred materials for ground stone from sandstone to granite in Tularosa Basin sites, and this pattern is reflected in the US 54 assemblages as well. In addition, deeply concave basin metate forms, likely associated with relatively non-intensive processing of gathered dry seed foods, dominate the Late Archaic assemblages at LA 128699 and LA 128700. During the Formative period, basin forms are still present, but the balance shifts toward flatter grinding surfaces. Most manos during both time periods are relatively small "one-hand" size, but there is some evidence for the addition of longer manos during the Formative. The combination of flat metate forms and somewhat longer manos implies a transition in grinding technology toward both greater grinding efficiency and longer grinding sessions associated with an increase in the reliance on seed crops, particularly cultigens.



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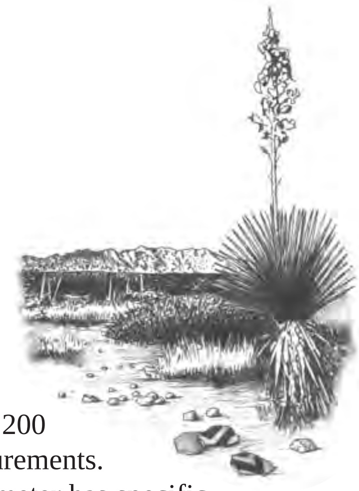
Chapter 22

# Source Provenience of Obsidian Artifacts

*M. Steven Shackley*



## Introduction

The majority of obsidian artifacts submitted for analysis from the sites in the Tularosa Basin were produced from obsidian whose primary source is in northern New Mexico. Secondary deposits are found in the Rio Grande River alluvium as far south as Chihuahua. It is impossible to determine conclusively whether the artifacts submitted were produced from primary or secondary material, but they were likely procured from the Rio Grande alluvium.

## Analysis And Instrumentation

All samples were analyzed whole with little or no formal preparation. The results presented here are quantitative in that they are derived from “filtered” intensity values proportioned to the appropriate x-ray continuum regions through a least squares fitting formula rather than plotting the proportions of the net intensities in a ternary system (McCarthy and Schamber 1981; Schamber 1977). These data, through the analysis of international rock standards, allow for inter-instrument comparison with a predictable degree of certainty (Hampel 1984).

The trace element analyses were performed in the Department of Geology and Geophysics, University of California, Berkeley, using a Philips PW 2400 wavelength x-ray fluorescence spectrometer with a LiF 200 crystal for all measurements. This crystal spectrometer has specific software written by Philips (SuperQ/quantitative) that modifies the instrument settings between elements of interest. Practical detection limits have not been calculated for this new instrument, but the variance from established standards is shown in Table 22.1. Sample selection is automated and controlled by the Philips software. X-ray intensity Ka-line data with the scintillation counter were measured for elements rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). X-ray intensities for barium (Ba) were measured with the flow counter from the La-line. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line established for each element from the analysis of international rock standards certified by the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). Specific standards used for the best fit regression calibration for elements Ti through Nb include G-2 (basalt), AGV-1 (andesite), GSP-1 and SY-2 (syenite), BHVO-1 (hawaiite), STM-1 (syenite), QLM-1 (quartz latite), RGM-1 (obsidian), W-2 (diabase), BIR-1

**Table 22.1 X-ray Fluorescence Concentrations for Selected Trace Elements in RGM-1**

| SAMPLE | Rubidium | Strontium | Yttrium | Zirconium | Niobium | Barium |
|---|---|---|---|---|---|---|
| RGM-1 (Govindaraju) | 149 | 108 | 25 | 219 | 8.9 | 807 |
| RGM-1 (Glascock and Anderson) | 145±3 | 120±10 | n.r.* | 150±7 | n.r.* | 826±31 |
| RGM-1 (this study) | 144.6±0.55 | 102.2±0.45 | 24±0 | 216.4±0.55 | 8.8±0.45 | 806.4±5 |

*n.r. = no report



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(basalt), SDC-1 (mica schist), TLM-1 (tonalite), SCO-1 (shale), all US Geological Survey standards, and BR-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994).

The data from the SuperQ software were translated directly into Excel™ for Windows software for manipulation and into SPSS™ for Windows for statistical analyses. In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run, an analysis of one standard included in the run is provided in Table 22.1. Source nomenclature follows Baugh and Nelson (1987), Glascock *et al.* (1999), and Shackley (1988, 1995, 1998a). Further information on the laboratory instrumentation can be found at: http://obsidian.pahma.berkeley.edu/ and Shackley (1998a). Trace element data exhibited in Tables 22.1 and 22.2 are reported in parts per million (ppm), a quantitative measure by weight (see also Figure 22.1).

## Silicic Volcanism In The Jemez Mountains And Secondary Depositional Effects

The Jemez Mountains, the Toledo and Valles Calderas in particular, have been the subject of intensive structural and petrological study, especially since the 1970s (Bailey *et al.* 1969; Gardner *et al.* 1986; Heiken *et al.* 1986; Ross *et al.* 1961; Self *et al.* 1986; Smith *et al.* 1970; [Figure 22.2]). This is due to its proximity and relationship to the Rio Grande Rift System, potential uranium ore, geothermal possibilities, an active magma chamber, and a number of other geologic subjects of interest. The 1986 Journal of Geophysical Research, Volume 91, devoted half of the volume to the, then current, research on the Jemez Mountains. Baugh and Nelson's (1987) article on the relationship between northern New Mexico archaeological obsidian sources and procurement on the southern Plains is more accessible for archaeologists.

Because of continuing tectonic stress along the Rio Grande, a lineament down into the mantle has produced a great amount of mafic volcanism during the last 13 million years (Self *et al.* 1986). As

**Table 22.2 Elemental Concentrations for Archaeological Samples (All Measurements in Parts per Million [ppm])**

| Site | Sample | Rubidium | Strontium | Yttrium | Zirconium | Niobium | Barium | Source |
|---|---|---|---|---|---|---|---|---|
| LA 6829 | 6829.676 | 197 | 8 | 61 | 176 | 92 | 18 | Cerro Toledo Rhy. |
| | 6829.897 | 480 | 8 | 83 | 139 | 214 | 14 | Mount Taylor |
| | 6829.1028 | 173 | 9 | 51 | 147 | 79 | 21 | Cerro Toledo Rhy. |
| | 6829.1741 | 96 | 81 | 24 | 122 | 31 | 1409 | Unknown |
| LA 115260 | 115260.3 | 198 | 9 | 62 | 178 | 96 | 26 | Cerro Toledo Rhy. |
| | 115262.15 | 204 | 6 | 63 | 179 | 97 | 17 | Cerro Toledo Rhy. |
| | 115262.16 | 201 | 7 | 62 | 183 | 94 | 19 | Cerro Toledo Rhy. |
| | 115262.2 | 500 | 9 | 72 | 116 | 180 | 42 | Mount Taylor |
| | 115262.27 | 560 | 8 | 79 | 123 | 197 | 19 | Mount Taylor |
| | 115262.79 | 202 | 6 | 61 | 181 | 94 | 12 | Cerro Toledo Rhy. |
| | 115262.81 | 533 | 10 | 74 | 120 | 188 | 30 | Mount Taylor |
| | 115262.19 | 199 | 7 | 59 | 176 | 94 | 2 | Cerro Toledo Rhy. |
| | 115262.21 | 200 | 7 | 61 | 175 | 91 | 14 | Cerro Toledo Rhy. |
| 128699 | 128699.53 | 195 | 8 | 61 | 169 | 91 | 51 | Cerro Toledo Rhy. |
| 128700 | 128700.66 | 4 | 576 | 11 | 20 | 5 | 1273 | Not obsidian |
| | 128700.73 | 36 | 78 | 28 | 82 | 4 | 0 | Not obsidian |
| | RGM-1-H-1 | 143 | 101 | 24 | 214 | 8 | 805 | Standard |

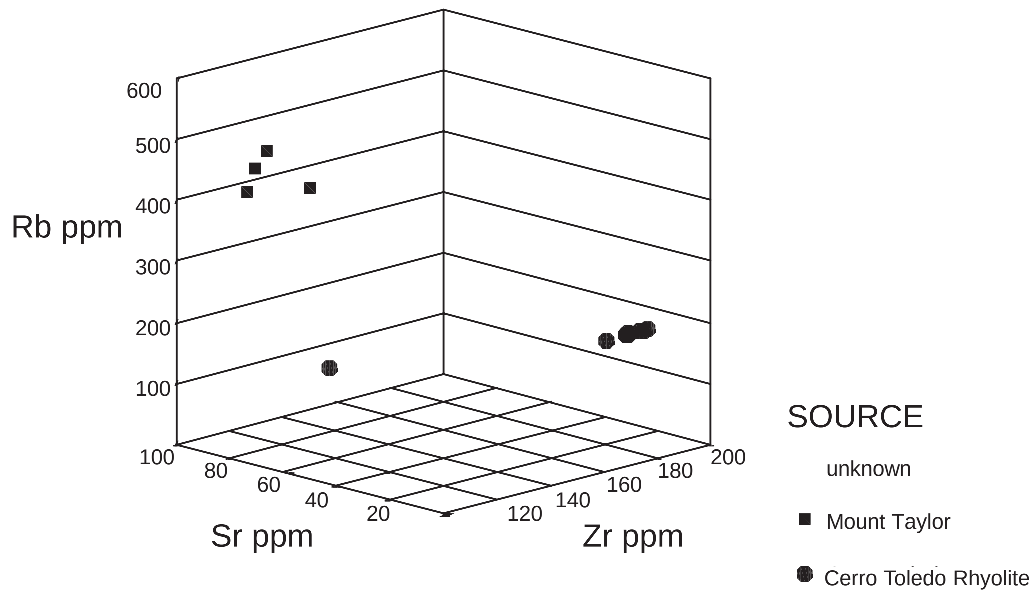



**Figure 22.1 Rb, Y, Zr three dimensional plot of archaeological data.**

in the Mount Taylor field to the west, earlier eruptive events during the Tertiary period (most likely related to the complex interaction of the Basin and Range and Colorado Plateau provinces) produced bimodal andesite-rhyolite fields, of which the Paliza Canyon (Keres Group), and probably the Polvadera Group, are a part (Shackley 1998a; Smith *et al.* 1970). While both appear to have produced artifact quality obsidian, the nodule sizes are relatively small due to hydration and devitrification over time (see Hughes and Smith 1993; Shackley 1990, 1998b). Rifting along the lineament, and other processes that are not well understood, led to the collapse of first the Toledo Caldera (ca. 1.45 Ma) and then the Valles Caldera (1.12 Ma). This collapse caused ring eruptive events that were dominated by crustally derived silicic volcanism and dome formation (Self *et al*. 1986). Because of their similar magmatic origins, the Cerro Toledo Rhyolite and Valles Grande Member obsidians are included in the Tewa Group. The slight difference in trace element chemistry is probably due to evolution of the magma from the Cerro Toledo event to the Valle Grande events (see Hildreth 1981; Mahood and Stimac 1990; Shackley 1998a, 1998b; [Figure 22.2]). Given the relatively recent events in the Tewa Group, nodule size is large and hydration and devitrification minimal, yielding the best natural glass media for tool production in the Jemez Mountains.

## Secondary Depositional Effects

Recent research by this lab investigating the secondary depositional regime from both the Jemez Mountains (Sierra del Valle), and the Mount Taylor Volcanic Field to the west, indicates that

1) Valle Grande Member rhyolite and obsidian in the Jemez Mountains, the result of the most recent eruptive event that produced glass in the caldera, does not erode out of the caldera,

2) Cerro Toledo Rhyolite and glass, mainly the result of the Rabbit Mountain ash flow eruption, deposited vast quantities of ash and quenched rhyolite in the Rio Grande River basin, and

3) the Grant's Ridge glass of the Mount Taylor Volcanic Field has been eroding through the Rio Puerco and Rio Grande systems since the Plio-Pleistocene (Shackley 1998a, 2000).

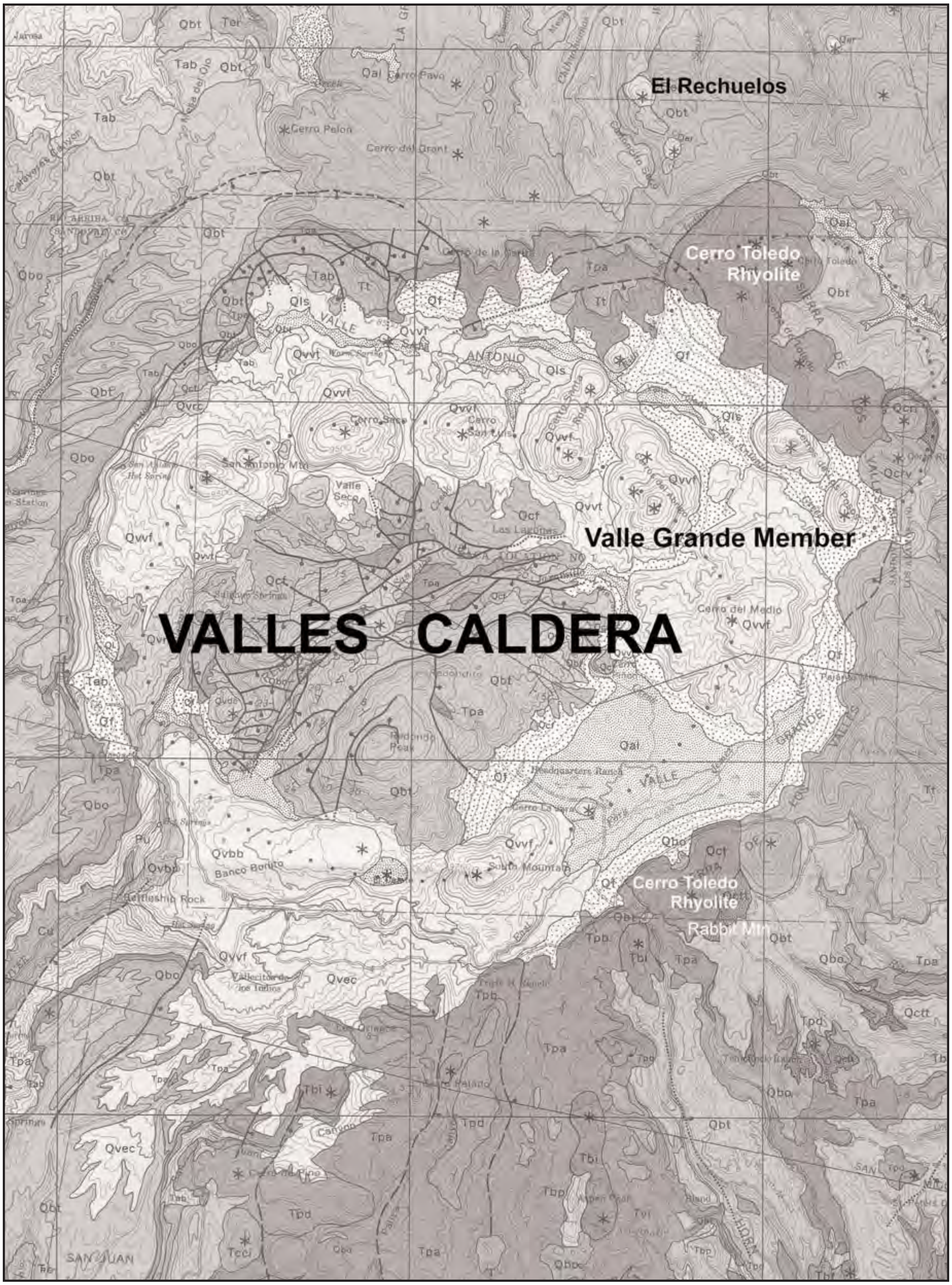



**Figure 22.2 Topographical rendering of a portion of the Jemez Mountains, Valles Caldera, and relevant features.**

Both Cerro Toledo Rhyolite glass and Mount Taylor glass are common in the Quaternary alluvium of the Rio Grande as far south as Chihuahua, and were frequently used as a tool-stone source in prehistory (Shackley 1997). It is impossible to determine in a finished artifact whether the raw material was procured from the primary or secondary source, unless the artifact is very large (>5–10 cm), when it can be assumed that the artifact was procured from nearer the primary geologic source. In larger assemblages, if Valle Grande glass is present, one can assume more confidently that the raw material was procured from the caldera proper.

## Geochemical Results And Summary

The vast majority of obsidian from these sites was probably procured from the Rio Grande alluvium (Tables 22.2 and 22.3). The absence of obsidian derived from the Valley Grande source supports this conclusion. One sample, 6829.1741, exhibits elemental concentrations that do not match any known source from the Southwest including Arizona, Chihuahua, New Mexico, and Sonora (Shackley 1995, 1998a, 1999). There are an unknown number of sources of obsidian in northern Mexico that have not yet been discovered. It is likely that this artifact was produced from one of the sources yet to be located in the basin and range region of northern Chihuahua. If so, than this specimen would represent more distant procurement than do the other samples in the analyzed assemblage.

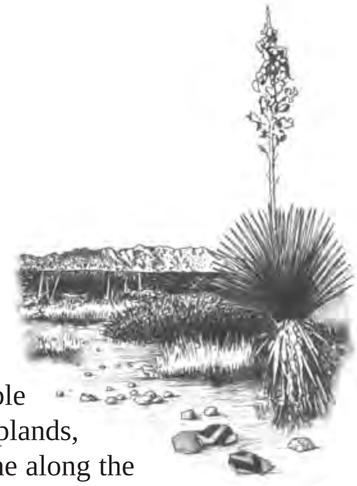
**Table 22.3 Site by Source Provenance**

| | | Source | | | |
|---|---|---|---|---|---|
| **Site** | | **Cerro Toledo Rhyolite** | **Mount Taylor** | **Unknown** | **Total** |
| **6829** | Count | 2 | 1 | 1 | 4 |
| | Percentage within Site | 50.0 | 25.0 | 25.0 | 100.0 |
| | Percentage within Source | 22.2 | 25.0 | 100.0 | 28.6 |
| | Percentage of Total | 14.3 | 7.1 | 7.1 | 28.6 |
| **115260** | Count | 6 | 3 | | 9 |
| | Percentage within Site | 66.7 | 33.3 | | 100.0 |
| | Percentage within Source | 66.7 | 75.0 | | 64.3 |
| | Percentage of Total | 42.9 | 21.4 | | 64.3 |
| **128699** | Count | 1 | | | 1 |
| | Percentage within Site | 100.0 | | | 100.0 |
| | Percentage within Source | 11.1 | | | 7.1 |
| | Percentage of Total | 7.1 | | | 7.1 |
| **Total** | Count | 9 | 4 | 1 | 14 |
| | Percentage within Site | 64.3 | 28.6 | 7.1 | 100.0 |
| | Percentage within Source | 100.0 | 100.0 | 100.0 | 100.0 |
| | Percentage of Total | 64.3 | 28.6 | 7.1 | 100.0 |

Chapter 23

# Faunal Remains

*Gwyneth A. Duncan, Dee Jones-Bartholomew, and Victoria D. Vargas*



## Introduction

Over 15,000 animal bone fragments were recovered from Jaca (LA 6829) and LA 115260. The majority of faunal materials (n=13,783) were recovered from LA 115260, an early Doña Ana-phase site (see Chapter 9). Considerably fewer fragments were obtained from LA 6829 (n=1,449), a Doña Ana/El Paso-phase site that was occupied ca. A.D. 1200. Small quantities of faunal remains were recovered from LA 115262 (n=7), LA 115265 (n=6), and LA 128699 (n=12). The fauna from the latter sites are simply summarized, and do not figure into the overall research issues explored in this chapter, which focuses on the remains from Jaca and LA 115260.

Overall, the faunal remains were in a relatively good state of preservation at LA 6829 and LA 115260. The assemblage from LA 115260 is one of the larger collections of faunal materials recovered from the Tularosa Basin and provided data that allowed exploration into issues concerning the environment exploited by the sites' inhabitants, seasons during which the sites were occupied, and the contribution of animal protein to the diet of the sites' inhabitants.

A main research focus of this chapter is the nutritional aspects reflected in the US 54 faunal assemblages. Ethnographic accounts and zooarchaeological evidence have demonstrated the importance of fat in the human diet. When animal meat is lean, it is of low nutritional value. Previous research has demonstrated the mainstay of prehistoric meat subsistence in the Tularosa Basin was a very lean animal—the jackrabbit. Therefore, subsistence strategies would have included not only intensive wild plant gathering and horticulture/ agriculture, but also at least occasional procurement of larger and more diverse game available in the neighboring uplands, or in the riverine zone along the Rio Grande (cf. O'Laughlin and Gerald 1977). Such a strategy would have required seasonal mobility and/or exchange relationships with other groups in the region. A key question here relates to the extent that the targeted plant and animal resources influenced the duration and season of occupation at LA 6829 and LA 115260. The data presented here, along with previous research in southeastern New Mexico, offer further insight into subsistence patterns in the southern Tularosa Basin.

## Methodology

Standardized recovery techniques were used to ensure that representative, comparable data were obtained from the various sites and contexts. In the field, faunal materials were recovered from both 1/4- and 1/8- inch screens and from flotation samples. The majority of faunal materials were from features, although some remains also came from non-feature contexts including the surface. All vertebrate faunal materials were processed and identified using standard zooarchaeological methods and procedures as follows.

The majority of faunal materials were washed to obtain accurate weights for biomass calculations. The initial stages of faunal identification included sorting all materials into the lowest possible classifications of identification using comparative zoological specimens. Ken and Marie Brown provided lagomorph (rabbit and hare) comparative specimens; specimens of birds, rodents, and various mammals were utilized at the University of New Mexico's Museum of Southwestern Biology, with the aid of William Gannon, Collections Manager. Other comparative speci-



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mens are in the possession of the senior author. Guidebooks were used as references, but family, genus, and species identifications were made using comparative specimens.

A large representation of birds in the archaeological assemblage was anticipated but never materialized. Therefore, after the initial identification stage a large percentage of faunal materials had been classified as Bird/Small Mammal with the majority of these being small mammal. A subsequent re-sort of this category was undertaken, particularly with the materials from LA 115260. This resulted in separating out a few bird bones, but primarily increased the small mammal and rodent counts.

In terms of numbers of bone examined, only 19.5 percent of the assemblage from LA 6829 and 31.5 percent of the assemblage from LA 115260 were identified beyond class. These are not unusually low percentages compared to other faunal analyses in the region. Only 27.2 percent of materials from a site in the upper Rio Hondo valley could be identified to categories beyond unidentifiable small, medium, and large mammal and bird (Wiseman 1996). At the Gobernadora site near El Paso, Texas, 19.6 percent of 10,181 faunal specimens were identified at least to the level of class (Miller 1990). The Turquoise Ridge site yielded 9,400 fragments of which only 18.3 percent were identifiable at least to the level of class (Whalen 1994b).

After all possible identifications, bones were counted, weighed, and examined for evidence of cultural modifications such as butchering marks and burning. Worked bone was most likely debris from subsistence before use as a tool or decorative item, and was analyzed accordingly. Diagnostic elements were sided and paired to determine minimum numbers of individuals (MNI). All data were recorded in Microsoft Access 2000.

Size categories used for unidentifiable mammal fragments were based on thickness of the compact tissue. Although somewhat arbitrary, size categories do serve as relative indicators even when species cannot be identified. For this project, size categories were recorded similar to Wiseman's (1996:157) classification used for the Mick-O'Hara assemblage. That is, small mammals were defined as jackrabbit size or smaller, medium mammals are larger than jackrabbit but smaller than a pronghorn antelope, and large mammals are pronghorn antelope size or larger. The number of individual specimens (NISP), or bone count, was the primary means by which faunal materials were quantified. Fragment counts are the most basic quantification method and allow for comparisons of frequencies of taxa, even if only to the level of class.

Zooarchaeological research has addressed many issues with respect to subsistence behavior patterns, while at the same time acknowledging biases inherent in faunal data. Faunal analysis involves certain methodological procedures, which have become standard practice but are not always practical or statistically meaningful. One such procedure is the use of minimum numbers of individuals (MNI) to indicate reliance, or emphasis, on whole animals (Reitz and Wing 1999). MNI calculations allow the analyst to determine meat weight based on whole individuals. This analytical procedure is pertinent to faunal materials recovered from sites where hunting activities played a large role in subsistence and in situations where whole animal carcasses would have been brought to a site for processing and/or consumption. However, MNI calculations overestimate meat weight in situations where only portions of an animal are transported to, and/or consumed at, a site. Using MNI to determine meat weight is also an inaccurate estimation since not all animals of the same species weigh the same, even if allowances are made for age differences. Probably the biggest problem with MNI counts is in the subjective process of establishing analytical units from which MNI determinations are made. The greater the number of analytical units, the higher the MNI counts will be. For this project,



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analytical units used to calculate MNI were strictly by feature. MNI were not calculated for the overall summary of fauna by site, nor were MNI calculated for non-feature fauna.

Whereas MNI statistics emphasize individual animals, biomass calculations emphasize the quantity of meat supplied by an animal based on the weight of the bone recovered. Biomass calculations are based on an allometric principle that proportions of body mass, skeletal mass, and skeletal dimensions change with increasing body size (Reitz et al. 1987). The premise is that X kilograms of archaeological bone weight represent a certain quantity of live meat weight (Y). Biomass infers the probability that only certain portions of animals were used at sites where preserved meats or redistributed meats were consumed. Calculations are based strictly on the archaeological bone weight by class of animal, thereby providing a relative means of comparison between classes irrespective of MNI (Table 23.1).

**Table 23.1 Allometric Values Used in the Current Study**

| Faunal Category | Y-Intercept (a) | Slope (b) |
|---|---|---|
| Reptile | 1.17 | 1.01 |
| Bird | 1.04 | 0.91 |
| Bird/Small Mammal | 1.08 | 0.905 |
| Mammal | 1.12 | 0.9 |

Formula is $Y=aX^b$, where Y is biomass or meat weight, X is bone weight, a is the Y-Intercept, and b is the slope (from Reitz *et al*. 1987; Wing and Brown 1979).

Both MNI and biomass calculations are subject to sample bias to the point that that Casteel (1978), Grayson (1984) and Wing and Brown (1979) have suggested a sample size of at least 1,400 identifiable bones or 200 individuals (MNI) in order for a sample to be statistically meaningful. However, Wing and Brown (1979) acknowledge the recommended sample size is based on assemblages from the Caribbean where species diversity is a large factor. "For those sites with faunal assemblages that have a low species diversity, such as most sites located in northern latitudes or at high altitudes or those with specialized diets, this criterion of adequacy would not be valid" (Wing and Brown 1979:119). Nevertheless, faunal data should be presented in a variety of ways so that comparisons of data from other sites, generated by other faunal analysts, can be made.

## Results

### ***LA 6829***

From this site 1,449 bone fragments were analyzed. Only two classes comprise the assemblage: bird and mammal as indicated in Table 23.2. The majority of fragments (n=637) were classified as Bird/Small Mammal and comprised 44 percent of the total NISP. Unidentifiable (UID) Small Mammal was the second largest category (n=466) for 32.2 percent of the total NISP. Black-tailed jackrabbit (*Lepus californicus*) was the most frequently identified species (n=137; 9.4 percent), and desert cottontail (*Sylvilagus audubonii*) was the second most frequently identified species (n=44; 3 percent). All lagomorphs combined comprise 17.8 percent of the total assemblage. Birds identified included both quail (*Callipepla* sp.) and hawk (*Buteo* sp.). Combined with UID Bird, their numbers comprised 1.5 percent of the total assemblage (n=22). Rodentia, including a fragment from the family Heteromyidae, comprised less than one percent of the total assemblage (n=13; 0.9 percent). Six artiodactyl fragments were identified and, combined with the large mammal fragments (n=4), comprised less than one percent of the total assemblage.

All lagomorphs were 37.1 percent of total biomass. Jackrabbit contributed the greatest amount of biomass, accounting for 28.8 percent of the total, while cottontail contributed only 3.5 percent. UID Small Mammal and Bird/Small Mammal provided 21.6 percent and 19.8 percent of total biomass, respectively. Artiodactyl and UID Large Mammal contributed just more than 13 percent of the total biomass. All other mammal categories were 5.3 percent of the total assemblage, while birds comprised 2.5 percent of the total biomass.

Minimum numbers of individuals (MNI) were calculated according to feature. Small sample

**Table 23.2 LA 6829 Site Summary of Fauna**

| Taxon | NISP | % NISP | Wt (g) | Biomass (kg) | % Biomass | Burned | Cut | Hacked | Worked |
|---|---|---|---|---|---|---|---|---|---|
| Phasianidae (Grouse, Turkeys, Quail) | 1 | 0.1 | 0.05 | 0.001 | <0.1 | | | | |
| *Callipepla* sp. (Quail) | 2 | 0.1 | 0.10 | 0.002 | 0.1 | | | | |
| *Buteo* sp. (Hawk) | 1 | 0.1 | 1.50 | 0.029 | 0.8 | | | | |
| UID Bird | 18 | 1.2 | 2.95 | 0.054 | 1.6 | 4 | | | |
| Bird/Small Mammal | 637 | 44.0 | 41.00 | 0.667 | 19.8 | 224 | | | |
| Leporidae (Rabbits and Hares) | 79 | 5.4 | 7.50 | 0.161 | 4.8 | 24 | | | |
| *Sylvilagus audubonii* (Desert Cottontail) | 44 | 3.0 | 5.65 | 0.118 | 3.5 | 13 | | 2 | |
| *Lepus californicus* (Black-tailed Jackrabbit) | 137 | 9.4 | 55.30 | 0.973 | 28.8 | 40 | | 1 | |
| *Rodentia* | 12 | 0.8 | 0.85 | 0.022 | 0.6 | 3 | | | |
| Heteromyidae (Pocket Mice and Kangaroo Rats) | 1 | 0.1 | 0.05 | 0.001 | <0.1 | | | | |
| *Artiodactyla* (Even-toed Hoofed Mammals) | 6 | 0.4 | 18.95 | 0.371 | 11.0 | 4 | | | |
| UID Small Mammal | 466 | 32.2 | 40.05 | 0.728 | 21.6 | 218 | | | |
| UID Small-medium Mammal | 1 | 0.1 | 0.20 | 0.006 | 0.2 | | | | |
| UID Medium Mammal | 1 | 0.1 | 0.60 | 0.016 | 0.5 | | | | |
| UID Med-large Mammal | 12 | 0.8 | 5.80 | 0.127 | 3.8 | 9 | | | 3? |
| UID Large Mammal | 4 | 0.3 | 3.00 | 0.070 | 2.1 | 4 | | | |
| UID Mammal | 14 | 1.0 | 1.10 | 0.028 | 0.8 | 4 | | | |
| UID Bone | 13 | 0.9 | 0.45 | - | - | 9 | | | |
| *Total* | *1449* | | *185.10* | *3.374* | | *556* | *0* | *3* | *3?* |
| UID Shell | 2 | | 0.10 | | | | | | |

size for each of the features resulted in the MNI being somewhat evenly distributed within the features. Not surprisingly, jackrabbit and cottontail were usually the most frequently occurring, but other animals such as bird, artiodactyl, and rodent sometimes were as frequent. Feature 17 is a good example of how lagomorphs greatly outnumber bird, rodent, and artiodactyl in terms of NISP but not in terms of MNI.

Of the modifications noted, 556 of the fragments were burned. Bird/Small Mammal and UID Small Mammal had the greatest numbers of burned bone (224 and 218, respectively). Thirty percent of the fragments identified as lagomorphs exhibited burning (n=77). Hack marks were noted on three bones, specifically cottontail (n=2) and jackrabbit (n=1). Three fragments identified as UID Medium-Large Mammal were possibly worked. These fragments exhibited striations, polishing, and were somewhat tapered.

Taphonomically, there was a high incidence of “weathered” fragments, which was also classified as “etched.” This weathering and/or etching might have been a result of vegetative roots taking advantage of the minerals in the bone, causing the surface of bones to have an etched appearance. On at least two occasions, bones from the same provenience were all etched except for those that had been burned. Perhaps burning altered the mineral composition of the bone to an extent that plants were not able to utilize them.

All of the feature and non-feature data from LA 6829, as indicated in Appendix E and Table 23.3, exhibited the same relative patterns inherent in the site summary and underlying pithouse. Feature 54 (Structures 1 and 2—the communal structure) contained 32.5 percent of the entire site assemblage, and Feature 17 (Structure 5—a pithouse) had the second highest percentage of materials from the site (17.2 percent). Although an increased number of analytical units can mean



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**Table 23.3 LA 6829 Non-feature Fauna**

| Taxon | NISP | % NISP | Wt (g) | Biomass (kg) | % Biomass | Burned | Cut | Hacked | Worked |
|---|---|---|---|---|---|---|---|---|---|
| *Buteo* sp. (Hawk) | 1 | 1.6 | 1.50 | 0.029 | 14.8 | | | | |
| UID Bird | 2 | 3.2 | 0.50 | 0.011 | 5.6 | | | | |
| Bird/Small Mammal | 27 | 43.5 | 1.65 | 0.036 | 18.4 | 14 | | | |
| *Sylvilagus audubonii* (Desert Cottontail) | 1 | 1.6 | 0.10 | 0.003 | 1.5 | 1 | | | |
| *Lepus californicus* (Black-tailed Jack Rabbit) | 5 | 8.1 | 1.40 | 0.035 | 17.9 | 3 | | | |
| Heteromyidae (Pocket Mice and Kangaroo Rats) | 1 | 1.6 | 0.05 | 0.001 | 0.5 | | | | |
| *Artiodactyla* (Even-toed Hoofed Mammals) | 1 | 1.6 | 0.05 | 0.001 | 0.5 | | | | |
| UID Small Mammal | 15 | 24.2 | 1.15 | 0.029 | 14.8 | 12 | | | |
| UID Med-Large Mammal | 4 | 6.5 | 1.50 | 0.037 | 18.9 | 3 | | | 2? |
| UID Large Mammal | 1 | 1.6 | 0.50 | 0.014 | 7.1 | 1 | | | |
| UID Bone | 4 | 6.5 | 0.10 | - | - | 1 | | | |
| *Total* | *62* | | *8.50* | *0.196* | | *35* | *0* | *0* | *2?* |

less meaningful data, the feature tables consistently indicate that UID Small Mammal and Bird/Small Mammal had the highest frequencies, while jackrabbit and cottontail were the most frequently occurring species. Although bird and large mammal are present, their relative percentages are extremely low compared with small mammal in every provenience.

## *LA 115260*

A total of 13,853 fragments was analyzed from this site, 70 of which were identified as human and will not be considered further in this discussion (see Chapter 29). Of the 13,783 fragments comprising the faunal assemblage, three classes were identified: reptile, bird, and mammal (Table 23.4). The majority of fragments were UID Small Mammal for 67.4 percent of the total assemblage (n=9,294). The second most frequent category was jackrabbit, comprising 13.2 percent of the collection (n=1,818). Leporidae was 10.8 percent of the entire assemblage (n=1,492), with the majority of these probably jackrabbit given the low frequency of identified cottontail (3.2 percent; n=446). Overall, all lagomorphs were 27.2 percent of the entire assemblage and the most frequently identified species.

Rodent was the second most frequently identified mammal, but comprised less than 4 percent of the total assemblage (n=478 for all *Rodentia*). Only two genera of rodents could be positively identified, ground/rock squirrel (*Spermophilus* sp.) and kangaroo rat (*Dipodomys* sp.). Three rodent bones were identified as Cricetidae (one tentatively).

Carnivore identified includes *Canis* sp. and badger (*Taxidea taxus*) together copmprising less than 1 percent of the total NISP (n=71). Only two fragments of artiodactyl were identified, comprising less than 1 percent of the total NISP.

Bird bones were present but infrequent. Two different species of quail were identified, *Cyrtonyx montezumae* (Montezuma quail) and *Callipepla* sp. (quail). All bird fragments comprised less than 0.5 percent of the total assemblage. The four snake vertebra and two lizard bones identified, along with other reptile bones, comprised less than 0.1 percent of the total assemblage.

Biomass calculations show UID Small Mammal and jackrabbit with the highest percentages, 38.4 percent and 36.4 percent respectively. All lagomorphs combined contributed 52.7 percent of total biomass. Carnivore biomass contributed

**Table 23.4 LA 115260 Site Summary of Fauna**

| Taxon | NISP | % NISP | Wt (g) | Biomass (kg) | % Biomass | Burned | Cut | Hacked | Worked |
|---|---|---|---|---|---|---|---|---|---|
| UID Lizard | 2 | <0.1 | 0.10 | 0.001 | <0.1 | 1 | | | |
| UID Snake | 4 | <0.1 | 0.20 | 0.002 | <0.1 | 1 | | | |
| UID Reptile | 1 | <0.1 | 0.05 | <0.001 | <0.1 | 1 | | | |
| Phasianidae (Grouse, Turkeys, Quail) | 2 | <0.1 | 0.55 | 0.011 | <0.1 | | | | |
| cf. Phasianidae | 13 | 0.1 | 1.20 | 0.024 | 0.1 | 2 | | | |
| *Cyrtonyx montezumae* (Montezuma Quail) | 1 | <0.1 | 0.10 | 0.002 | <0.1 | | | | |
| *Callipepla* sp. (Quail) | 2 | <0.1 | 0.25 | 0.005 | <0.1 | | | | |
| UID Small Bird | 35 | 0.3 | 1.90 | 0.036 | 0.2 | 1 | | | |
| Leporidae (Rabbits and Hares) | 1492 | 10.8 | 150.10 | 2.391 | 11.4 | 726 | | 1 | |
| *Sylvilagus audubonii* (Desert Cottontail) | 446 | 3.2 | 57.60 | 1.010 | 4.8 | 186 | 1 | | |
| *Lepus californicus* (Black-tailed Jackrabbit) | 1818 | 13.2 | 546.85 | 7.657 | 36.4 | 748 | | 14 | |
| cf. *Lepus californicus* | 7 | 0.1 | 1.25 | 0.032 | 0.1 | 7 | | | |
| *Rodentia* (Rodents) | 455 | 3.3 | 23.90 | 0.457 | 2.2 | 266 | | | |
| *Spermophilus* sp. (Ground or Rock Squirrels) | 1 | <0.1 | 0.05 | 0.001 | <0.1 | | | | |
| Heteromyidae (Pocket Mice and Kangaroo Rats) | 15 | 0.1 | 0.80 | 0.021 | 0.1 | 2 | | | |
| *Dipodomys* sp. (Kangaroo Rat) | 4 | <0.1 | 0.25 | 0.007 | <0.1 | | | | |
| Cricetidae (New World Mice and Rats) | 2 | <0.1 | 0.10 | 0.003 | <0.1 | 2 | | | |
| cf. Cricetidae | 1 | <0.1 | 0.05 | 0.001 | <0.1 | 1 | | | |
| *Carnivora* (Carnivores) | 46 | 0.3 | 9.30 | 0.195 | 0.9 | 34 | | | |
| *Canis* sp. (Wolves, Foxes, Coyote, and Dog) | 11 | 0.1 | 11.40 | 0.235 | 1.1 | 4 | | | |
| *Taxidea taxus* (Badger) | 13 | 0.1 | 12.00 | 0.246 | 1.2 | 8 | | 3 | |
| cf. *Taxidea taxus* | 1 | <0.1 | 0.60 | 0.016 | 0.1 | | | | |
| *Artiodactyla* (Even-toed Hoofed Mammals) | 2 | <0.1 | 1.80 | 0.044 | 0.2 | 1 | | | |
| UID Small Mammal | 9294 | 67.4 | 580.85 | 8.084 | 38.4 | 4707 | | | 1 |
| UID Small-medium Mammal | 5 | <0.1 | 0.70 | 0.019 | 0.1 | 1 | | | |
| UID Medium Mammal | 85 | 0.6 | 17.25 | 0.341 | 1.6 | 50 | | | |
| UID Med-Large Mammal | 15 | 0.1 | 5.40 | 0.119 | 0.6 | 3 | | | |
| UID Large Mammal | 3 | <0.1 | 0.90 | 0.023 | 0.1 | 1 | | | |
| UID Mammal | 7 | 0.1 | 1.80 | 0.044 | 0.2 | 2 | | | 1 |
| *Total* | *13783* | | *1427.30* | *21.027* | | *6755* | *1* | *18* | *2* |
| Human | 57 | | 14.25 | | | 3 | 0 | 0 | 0 |
| cf. Human | 13 | | 6.30 | | | 0 | 0 | 0 | 0 |
| *Total* | *70* | | *20.55* | | | *3* | *0* | *0* | *0* |
| UID Shell | 3 | | 0.25 | | | 0 | 0 | 0 | 2 |



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3.3 percent with badger accounting for at least 1.2 percent. All rodent contributed less than 3 percent biomass and bird contributed less than 1 percent. Besides UID Small Mammal, all other unidentifiable mammals contributed 2.6 percent of the biomass. Reptile accounted for less than 0.1 percent of total biomass.

MNI was calculated by feature. As it turned out, the large assemblages from Feature 1, the large midden (Table 23.5), and Feature 1A (Table 23.6) provided a statistically viable sample for this method of calculation. Jackrabbit outnumbered cottontail nearly 2:1 in Feature 1 and 3:1 in Feature 1A. In Feature 1, rodent was four times more frequent than bird, and twice as frequent as both reptile and carnivore. Lagomorph was 17 times more frequent than rodent. In Feature 1A, lagomorph was eight times more frequent than either bird or rodent and four times as frequent as carnivore. As sample size decreases, ratios become closer to 1:1.

Modifications included burning, cutting, hacking, and working. Burning was noted on 6,755 fragments, the majority of these classified as UID Small Mammal. Cut marks were noted on one cottontail bone, and hacking was observed on 14 jackrabbit bones and one Leporidae fragment. Two worked bones were from a UID Small Mammal and a UID Mammal. These fragments exhibited striations and/or polishing and were somewhat tapered.

Overall, the faunal remains from LA 115260 were in much better condition than those from LA 6829. The weathering/etching noted so frequently at LA 6829 was not prevalent at LA 115260, with one notable exception; most faunal materials recovered from Feature 1, Level 2, were etched.

The majority of faunal remains at LA 115260 were recovered from Feature 1, which contained 82.6 percent of the faunal materials from the entire site. Feature 1, Feature 2 (Table 23.7), and all the other features (Table 23.8), as well as the non-feature data (Table 23.9), show similar frequencies of NISP, biomass, and modifications as in the site summary table. The feature tables indicate, consistently, that UID Small Mammal and Bird/Small Mammal have the highest frequencies, while jackrabbit and cottontail are the most frequently occurring species. Although reptile, bird, and large mammal were identified, their relative percentages were extremely low compared with small mammal.

## Element Distributions

Element distributions were tabulated for Leporidae, *Lepus californicus*, and *Sylvilagus audubonii* by site (Table 23.10). The histograms for each site (Figures 23.1 and 23.2) indicate a bimodal distribution of elements with regard to the fore limb and hind limb elements. That is, both fore and hind limb elements occur with greater frequencies than cranial and axial elements (vertebrae and ribs). No vertebrae or ribs were identified as lagomorph from LA 6829. The histogram for LA 115260 also shows a bimodal distribution of front and hind limb elements. The lack of axial elements at LA 6829 was partly due to the difficulty in identifying ribs and vertebrae to the level of order or lower, unless vertebrae were complete. More importantly, however, there was a paucity of vertebrae and ribs recovered archaeologically. Metapodials and phalanges were consistently high at both sites and frequently classified below the level of Leporidae due to the difficulty in differentiating between jackrabbit and cottontail other than using size as a criterion.

There are differences, however, between LA 6829 and LA 115260 with regard to cottontail and jackrabbit element distributions (see Figures 23.1 and 23.2). Cottontail mandibles are more frequent than jackrabbit mandibles at LA 6829, but the opposite is true at LA 115260. Cottontail and jackrabbit scapulae occur with similar frequencies at LA 115260, but cottontail scapulae are more frequent than jackrabbit scapulae at LA 6829. Cottontail humeri are nearly twice as frequent at LA 115260 than jackrabbit, whereas jackrabbit humeri occur twice as frequently at LA 6829 than



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**Table 23.5 LA 115260 Feature 1 Fauna**

| Taxon | NISP | % NISP | Wt. (g) | Biomass (kg) | % Biomass | MNI | % MNI | Burned | Cut | Hacked | Worked |
|---|---|---|---|---|---|---|---|---|---|---|---|
| UID Lizard | 1 | <0.1 | 0.05 | <0.001 | <0.1 | 1 | 1.3 | 1 | | | |
| UID Snake | 4 | <0.1 | 0.20 | 0.002 | <0.1 | 1 | 1.3 | 1 | | | |
| UID Reptile | 1 | <0.1 | 0.05 | <0.001 | <0.1 | | | 1 | | | |
| cf. Phasianidae (Grouse, Turkeys, Quail) | 13 | 0.1 | 1.20 | 0.024 | 0.1 | | | 2 | | | |
| *Cyrtonyx montezumae* (Montezuma Quail) | 1 | <0.1 | 0.10 | 0.002 | <0.1 | 1 | 1.3 | | | | |
| UID Small Bird | 33 | 0.3 | 1.80 | 0.034 | 0.2 | | | 1 | | | |
| Leporidae (Rabbits and Hares) | 1263 | 11.1 | 128.95 | 2.086 | 11.5 | | | 636 | | 1 | |
| *Sylvilagus audubonii* (Desert Cottontail) | 403 | 3.5 | 52.75 | 0.933 | 5.1 | 25 | 31.6 | 167 | 1 | | |
| *Lepus californicus* (Black-tailed Jackrabbit) | 1577 | 13.8 | 474.40 | 6.737 | 37.0 | 45 | 57.0 | 663 | | 9 | |
| cf. *Lepus californicus* | 1 | <0.1 | 0.30 | 0.008 | <0.1 | | | 1 | | | |
| *Rodentia* (Rodents) | 374 | 3.3 | 20.10 | 0.391 | 2.1 | | | 224 | | | |
| *Spermophilus* sp. (Ground or Rock Squirrels) | 1 | <0.1 | 0.05 | 0.001 | <0.1 | 1 | 1.3 | 0 | | | |
| Heteromyidae (Pocket Mice and Kangaroo Rats) | 11 | 0.1 | 0.60 | 0.016 | 0.1 | | | 1 | | | |
| *Dipodomys* sp. (Kangaroo Rat) | 4 | <0.1 | 0.25 | 0.007 | <0.1 | 2 | 2.5 | 0 | | | |
| Cricetidae (New World Mice and Rats) | 2 | <0.1 | 0.10 | 0.003 | <0.1 | 1 | 1.3 | 2 | | | |
| cf. Cricetidae | 1 | <0.1 | 0.05 | 0.001 | <0.1 | | | 1 | | | |
| *Carnivora* (Carnivores) | 40 | 0.4 | 8.65 | 0.183 | 1.0 | | | 28 | | | |
| *Canis* sp. (Wolves, Foxes, Coyote, and Dog) | 9 | <0.1 | 9.70 | 0.203 | 1.1 | 1 | 1.3 | 2 | | | |
| *Taxidea taxus* (Badger) | 12 | 0.1 | 11.70 | 0.240 | 1.3 | 1 | 1.3 | 8 | | 3 | |
| cf. *Taxidea taxus* | 1 | <0.1 | 0.60 | 0.016 | 0.1 | | | 0 | | | |
| UID Small Mammal | 7554 | 66.3 | 486.70 | 6.895 | 37.9 | | | 3895 | | | 1 |
| UID Small-medium Mammal | 4 | <0.1 | 0.50 | 0.014 | 0.1 | | | 0 | | | |
| UID Medium Mammal | 61 | 0.5 | 12.20 | 0.249 | 1.4 | | | 41 | | | |
| UID Med-Large Mammal | 12 | 0.1 | 4.70 | 0.105 | 0.6 | | | 3 | | | |
| UID Large Mammal | 2 | <0.1 | 0.70 | 0.019 | 0.1 | | | 1 | | | |
| UID Mammal | 3 | <0.1 | 0.80 | 0.021 | 0.1 | | | 2 | | | 1 |
| *Total* | *11388* | | *1217.20* | *18.190* | | *79* | | *5681* | *1* | *13* | *2* |
| Human | 54 | | 13.35 | | | | | 3 | 0 | 0 | 0 |
| cf. Human | 11 | | 2.20 | | | | | 0 | 0 | 0 | 0 |
| *Total* | *65* | | *15.55* | | | | | *3* | *0* | *0* | *0* |
| UID Shell | 2 | | 0.20 | | | | | 0 | 0 | 0 | 1 |

**Table 23.6 LA 115260 Feature 1A Fauna**

| Taxon | NISP | % NISP | Wt(g) | Biomass (kg) | % Biomass | MNI | % MNI | Burned | Cut | Hacked | Worked |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Phasianidae (Grouse, Turkeys, Quail) | 1 | 0.1 | 0.05 | 0.001 | <0.1 | | | | | | |
| *Callipepla* sp. (Quail) | 1 | 0.1 | 0.05 | 0.001 | <0.1 | 1 | 8.3 | | | | |
| Leporidae (Rabbits and Hares) | 102 | 9.0 | 8.40 | 0.178 | 9.3 | | | 39 | | | |
| *Sylvilagus audubonii* (Desert Cottontail) | 23 | 2.0 | 2.80 | 0.066 | 3.5 | 2 | 16.7 | 11 | | | |
| *Lepus californicus* (Black-tailed Jackrabbit) | 112 | 9.8 | 31.65 | 0.589 | 30.8 | 6 | 50.0 | 48 | | 2 | |
| *Rodentia* (Rodents) | 49 | 4.3 | 2.40 | 0.057 | 3.0 | | | 26 | | | |
| Heteromyidae (Pocket Mice and Kangaroo Rats) | 2 | 0.2 | 0.10 | 0.003 | 0.2 | 1 | 8.3 | | | | |
| *Carnivora* (Carnivores) | 3 | 0.3 | 0.35 | 0.010 | 0.5 | | | 3 | | | |
| *Taxidea taxus* (Badger) | 1 | 0.1 | 0.30 | 0.008 | 0.4 | 1 | 8.3 | | | | |
| *Artiodactyla* (Even-toed Hoofed Mammals) | 2 | 0.2 | 1.80 | 0.044 | 2.3 | 1 | 8.3 | 1 | | | |
| UID Small Mammal | 818 | 72.0 | 48.60 | 0.866 | 45.3 | | | 404 | | | |
| UID Medium Mammal | 17 | 1.5 | 2.35 | 0.056 | 2.9 | | | 4 | | | |
| UID Med-Large Mammal | 3 | 0.3 | 0.70 | 0.019 | 1.0 | | | | | | |
| UID Mammal | 2 | 0.2 | 0.50 | 0.014 | 0.7 | | | | | | |
| *Total* | *1136* | | *100.05* | *1.912* | | *12* | | *536* | *0* | *2* | *0* |
| cf. Human | 2 | | 4.10 | | | | | | | | |

cottontail. Jackrabbit ulnae are five times more frequent at LA 6829 than cottontail, whereas cottontail ulnae occur with a higher frequency at LA 115260. No cottontail innominate were identified from LA 6829, but occurred with a greater frequency than jackrabbit at LA 115260. Cottontail femur occurred with a greater frequency than that of jackrabbit at LA 115260, but with less frequency than jackrabbit LA 6829. Tibiae occurred with similar frequencies for both cottontail and jackrabbit at LA 115260, but cottontail tibiae were more frequent at LA 6829 than jackrabbit. Cottontail calcanei occurred with greater frequencies than jackrabbit at both sites.

The histogram for cottontail (Figure 23.1) shows cranium and mandible elements at LA 6829 far exceed those at LA 115260. Also, cottontail from LA 6829 has a more evenly distributed bimodal distribution, that is, scapula/radius and tibia/calcaneus occur in similar frequencies. The humeri and femurs decrease in somewhat similar proportions at LA 6829, and innominate are absent. In contrast, the humerus, innominate, and femur are the most prevalent elements for cottontail at LA 115260.

For jackrabbit, the histogram in Figure 23.2 graphically demonstrates cranium and mandible elements occur with similar frequencies at both sites. Fore limb elements seem to be more evenly distributed at LA 115260 than at LA 6829. The humeruii is the most prevalent element at LA 6829 and occurs twice as frequently as humerus at LA 115260. Hind limb frequencies occur in similar relative frequencies both between and within sites except for the femur and metatarsal, which are more frequent at LA 6829 than LA 115260.

Although the element distributions could be a result of taphonomic factors, recovery methods and techniques, and/or identification discrepancies, they could also be indicators of meat processing and consumption methods.



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**Table 23.7 LA 115260 Feature 2 Fauna**

| Taxon | NISP | % NISP | Wt.(g) | Biomass (kg) | % Biomass | MNI | % MNI | Burned | Cut | Hacked | Worked |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Phasianidae (Grouse, Turkeys, Quail) | 1 | 0.1 | 0.50 | 0.010 | 0.8 | | | | | | |
| *Callipepla* sp. (Quail) | 1 | 0.1 | 0.20 | 0.004 | 0.3 | 1 | 10.0 | | | | |
| UID Small Bird | 2 | 0.3 | 0.10 | 0.002 | 0.2 | | | | | | |
| Leporidae (Rabbits and Hares) | 105 | 13.3 | 10.25 | 0.213 | 16.3 | | | 47 | | | |
| *Sylvilagus audubonii* (Desert Cottontail) | 10 | 1.3 | 0.95 | 0.025 | 1.9 | 2 | 20.0 | 3 | | | |
| *Lepus californicus* (Black-tailed Jackrabbit) | 84 | 10.6 | 24.95 | 0.475 | 36.4 | 4 | 40.0 | 17 | | 1 | |
| cf. *Lepus californicus* | 6 | 0.8 | 0.95 | 0.025 | 1.9 | | | 6 | | | |
| *Rodentia* (Rodents) | 30 | 3.8 | 1.30 | 0.033 | 2.5 | 2 | 20.0 | 16 | | | |
| *Carnivora* (Carnivores) | 3 | 0.4 | 0.30 | 0.008 | 0.6 | | | 3 | | | |
| *Canis* sp. (Wolves, Foxes, Coyote, and Dog) | 1 | 0.1 | 0.10 | 0.003 | 0.2 | 1 | 10.0 | 1 | | | |
| UID Small Mammal | 542 | 68.4 | 23.40 | 0.449 | 34.4 | | | 229 | | | |
| UID Medium Mammal | 5 | 0.6 | 2.10 | 0.051 | 3.9 | | | 4 | | | |
| UID Large Mammal | 1 | 0.1 | 0.20 | 0.006 | 0.5 | | | | | | |
| *Total* | *791* | | *65.30* | *1.304* | | *10* | | *326* | *0* | *1* | *0* |
| Human | 3 | | 0.90 | | | | | | | | |
| UID Shell | 1 | | 0.05 | | | | | | | | 1 |

**Table 23.8 LA 115260 Fauna by Primary Feature**

| Primary Feature | Taxon | NISP | % NISP | Wt. (g) | Biomass (kg) | % Biomass | MNI | % MNI | Burned | Cut | Hacked | Worked |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 03 | Bird/Small Mammal | 24 | 27.9 | 1.1 | 0.025 | 17.2 | | | 11 | | | |
| 03 | Leporidae (Rabbits and Hares) | 3 | 3.5 | 0.2 | 0.006 | 4.1 | | | 1 | | | |
| 03 | *Sylvilagus audubonii* (Desert Cottontail) | 4 | 4.6 | 0.3 | 0.008 | 5.5 | 1 | 50.0 | 2 | | | |
| 03 | Lepus californicus (Black-tailed Jackrabbit) | 3 | 3.5 | 0.9 | 0.023 | 15.9 | 1 | 50.0 | 1 | | | |
| 03 | UID Small Mammal | 52 | 60.5 | 3.6 | 0.083 | 57.2 | | | 35 | | | |
| *03 Subtotal* | | *86* | | *6.1* | *0.145* | | *2* | | *50* | | | |
| 04 | Bird/Small Mammal | 7 | 63.6 | 0.4 | 0.010 | 21.3 | | | 3 | | | |
| 04 | Lepus californicus (Black-tailed Jackrabbit) | 4 | 36.4 | 1.5 | 0.037 | 78.7 | 2 | | 3 | | | |
| *04 Subtotal* | | *11* | | *1.9* | *0.047* | | *2* | | *6* | | | |
| 05 | Bird/Small Mammal | 5 | 83.3 | 0.3 | 0.007 | 53.8 | | | 2 | | | |
| 05 | UID Small Mammal | 1 | 16.7 | 0.2 | 0.006 | 46.2 | | | | | | |
| *05 Subtotal* | | *6* | | *0.5* | *0.013* | | | | *2* | | | |



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**Table 23.8 LA 115260 Fauna by Primary Feature (continued)**

| Primary Feature | Taxon | NISP | % NISP | Wt. (g) | Biomass (kg) | % Biomass | MNI | % MNI | Burned | Cut | Hacked | Worked |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07 | Bird/Small Mammal | 21 | 63.6 | 0.7 | 0.016 | 36.4 | | | 5 | | | |
| 07 | Leporidae (Rabbits and Hares) | 3 | 9.1 | 0.2 | 0.006 | 13.6 | | | | | | |
| 07 | *Sylvilagus audubonii* (Desert Cottontail) | 1 | 3.0 | 0.2 | 0.006 | 13.6 | 1 | 50.0 | | | | |
| 07 | *Lepus californicus* (Black-tailed Jackrabbit) | 3 | 9.1 | 0.3 | 0.008 | 18.2 | 1 | 50.0 | | | | |
| 07 | UID Small Mammal | 5 | 15.2 | 0.3 | 0.008 | 18.2 | | | 3 | | | |
| *07 Subtotal* | | *33* | | *1.7* | *0.044* | | *2* | | *8* | | | |
| 08 | Bird/Small Mammal | 7 | | 0.4 | 0.010 | | | | 3 | | | |
| 011 | *Lepus californicus* (Black-tailed Jackrabbit) | 3 | 30.0 | 0.35 | 0.010 | 41.7 | 1 | | 1 | | | |
| 011 | UID Small Mammal | 7 | 70.0 | 0.50 | 0.014 | 58.3 | | | 4 | | | |
| *011 Subtotal* | | *10* | | *0.85* | *0.024* | | *1* | | *5* | | | |
| 012 | Bird/Small Mammal | 2 | 50.0 | 0.05 | 0.001 | 10.0 | | | 1 | | | |
| 012 | *Lepus californicus* (Black-tailed Jackrabbit) | 1 | 25.0 | 0.20 | 0.006 | 60.0 | 1 | | | | | |
| 012 | UID Small Mammal | 1 | 25.0 | 0.10 | 0.003 | 30.0 | | | | | | |
| *012 Subtotal* | | *4* | | *0.35* | *0.01* | | *1* | | *1* | | | |
| 013 | UID Lizard | 1 | 0.9 | 0.05 | | | 1 | 16.7 | | | | |
| 013 | Bird/Small Mammal | 89 | 80.9 | 4.10 | 0.083 | 44.9 | | | 40 | | | |
| 013 | Leporidae (Rabbits and Hares) | 4 | 3.6 | 0.35 | 0.010 | 5.4 | | | 1 | | | |
| 013 | *Sylvilagus audubonii* (Desert Cottontail) | 3 | 2.7 | 0.20 | 0.006 | 3.2 | 1 | 16.7 | 2 | | | |
| 013 | *Lepus californicus* (Black-tailed Jackrabbit) | 9 | 8.2 | 2.95 | 0.069 | 37.3 | 2 | 33.3 | 3 | | 1 | |
| 013 | *Rodentia* (Rodents) | 2 | 1.8 | 0.10 | 0.003 | 1.6 | 2 | 33.3 | | | | |
| 013 | UID Mammal | 2 | 1.8 | 0.50 | 0.014 | 7.6 | | | | | | |
| *013 Subtotal* | | *110* | | *8.25* | *0.185* | | *6* | | *46* | *0* | *1* | *0* |
| 014a | Bird/Small Mammal | 1 | | 0.05 | 0.001 | | | | 1 | | | |



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**Table 23.9 LA 115260 Non-feature Fauna**

| Taxon | NISP | %NISP | Wt. (g) | Biomass (kg) | % Biomass | Burned | Cut | Hacked | Worked |
|---|---|---|---|---|---|---|---|---|---|
| Leporidae (Rabbits and Hares) | 12 | 6.0 | 1.75 | 0.043 | 8.0 | 2 | | | |
| *Sylvilagus audubonii* (Desert Cottontail) | 2 | 1.0 | 0.40 | 0.011 | 2.0 | 1 | | | |
| *Lepus californicus* (Black-tailed Jackrabbit) | 22 | 11.0 | 9.65 | 0.202 | 37.7 | 12 | | 1 | |
| Heteromyidae (Pocket Mice and Kangaroo Rats) | 2 | 1.0 | 0.10 | 0.003 | 0.6 | 1 | | | |
| *Canis* sp. ( Wolves, Foxes, Coyote and Dog) | 1 | 0.5 | 1.60 | 0.040 | 7.5 | 1 | | | |
| UID Small Mammal | 158 | 79.0 | 10.35 | 0.215 | 40.1 | 71 | | | |
| UID Small-medium Mammal | 1 | 0.5 | 0.20 | 0.006 | 1.1 | 1 | | | |
| UID Medium Mammal | 2 | 1.0 | 0.60 | 0.016 | 3.0 | 1 | | | |
| *Total* | *200* | | *24.65* | *0.536* | | *90* | *0* | *1* | *0* |

**Table 23.10 Element Distribution Values for *S. audubonii* and *L. californicus* by Site**

| Element | LA 6829 *S.audubonii* | LA 115260 *S.audubonii* | LA 6829 *L.californicus* | LA 115260 *L.californicus* |
|---|---|---|---|---|
| Cranium | 4.5 | 2.0 | 4.4 | 8.2 |
| Mandible | 13.6 | 4.0 | 3.6 | 7.7 |
| Mand/max | 0.0 | 0.0 | 0.0 | 0.0 |
| Maxilla | 2.3 | 4.0 | 1.5 | 3.1 |
| Premaxilla | 0.0 | 0.7 | 0.0 | 1.3 |
| Tooth | 0.0 | 1.3 | 4.4 | 4.0 |
| Scapula | 11.4 | 7.0 | 8.0 | 6.9 |
| Humerus | 6.8 | 11.7 | 16.1 | 6.2 |
| Radius | 11.4 | 6.7 | 10.2 | 7.4 |
| Ulna | 2.3 | 7.6 | 10.9 | 5.2 |
| Cuboid | 0.0 | 0.0 | 0.0 | 1.3 |
| Navicular | 2.3 | 1.3 | 0.0 | 2.3 |
| Carpal | 0.0 | 0.0 | 0.0 | 0.1 |
| Atlas | 0.0 | 0.0 | 0.0 | 0.0 |
| Vertebra | 0.0 | 0.4 | 0.0 | 0.1 |
| Rib | 0.0 | 0.0 | 0.0 | 0.0 |
| Innominate | 0.0 | 9.2 | 4.4 | 6.2 |
| Femur | 4.5 | 9.6 | 8.0 | 5.7 |
| Patella | 0.0 | 0.0 | 0.0 | 0.7 |
| Tibia | 11.4 | 8.5 | 8.0 | 8.4 |
| Metatarsal | 0.0 | 0.0 | 2.2 | 0.2 |
| Calcaneus | 11.4 | 12.1 | 5.1 | 7.1 |
| Astragalus | 0.0 | 1.6 | 1.5 | 3.3 |
| Metapodial | 11.4 | 8.3 | 10.9 | 12.9 |
| Carpal/tarsal | 0.0 | 0.0 | 0.0 | 0.1 |
| Phalanx | 6.8 | 3.8 | 0.7 | 1.5 |



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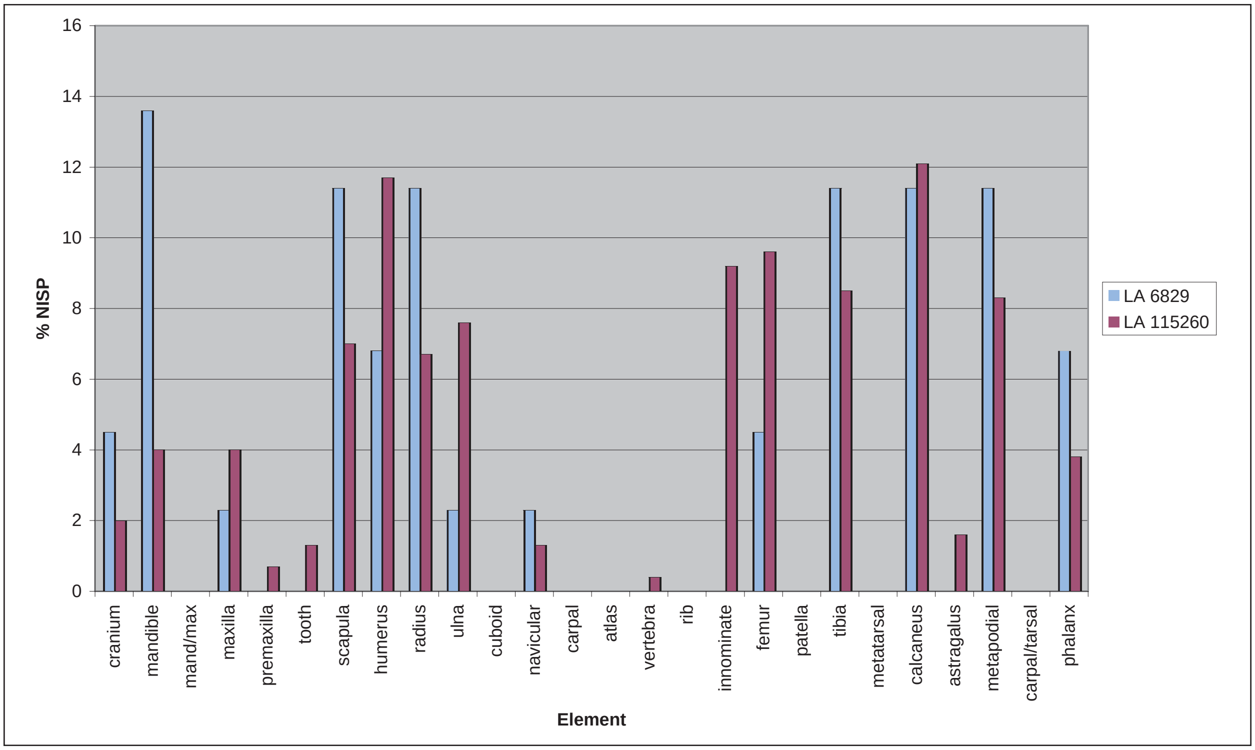


**Figure 23.1** ***S. audubonii*** **elements by site.**

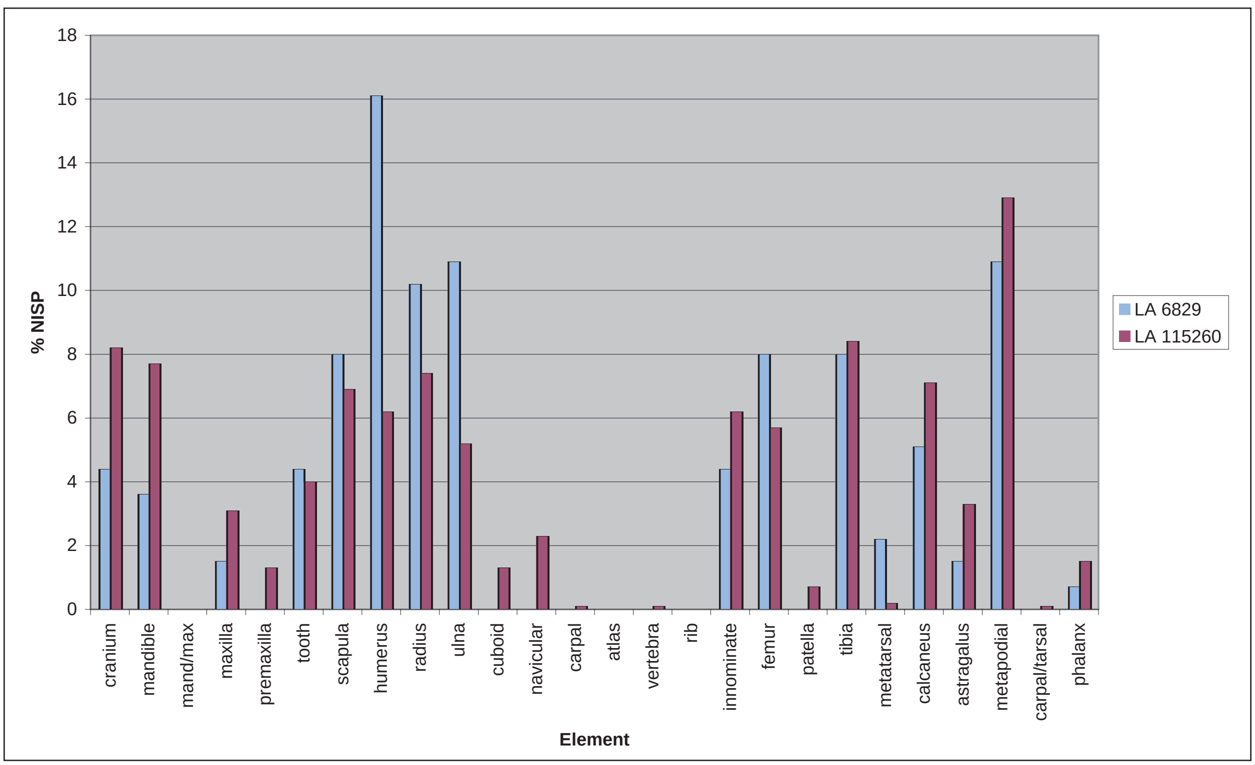


**Figure 23.2** ***L. californicus*** **elements by site.**



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## Natural Setting and Animal Habitats

The desert floor of the southern Tularosa Basin is resource-poor in terms of animal subsistence potential. The neighboring mountains and, especially, the riverine zone along the Rio Grande, offered a more diverse range of species. Importantly, these included larger mammals such as deer and desert bighorn sheep, which are not typically found on the desert floor. Desert bighorn sheep probably inhabited the Jarilla Mountains, but it is unlikely deer were present in appreciable numbers anywhere in the basin. Jaca and LA 115260 are situated within 8 km (5 miles) of the southern end of the Jarilla Mountains, but the Organ Mountains and Sacramento Mountains are more distant, located approximately 40 km (25 miles) to the west and northeast, respectively. The Rio Grande is even further away, with the closest approach to these sites located approximately 55 km (34 miles) to the southwest. See Chapter 2 for a discussion of the environmental context.

The identified animal species from both LA 6829 and LA 115260 were almost all inhabitants of the desert floor, and this may be a factor of distances to the more productive montane and riverine habitat zones. One quail bone was identified from a species that inhabits an upland environment (Montezuma gril), but all the other identified materials were from animals taken readily in the Tularosa Basin. Some of the faunal remains could have been the result of post-occupation deposition, but there is no strong evidence to suggest this. Such evidence would have been articulated skeletons and complete, or nearly complete, specimens; all of which were lacking in the assemblages.

If a case were to be made that commensal (post occupational) specimens were recovered, the reptiles identified from LA 115260 would be the most likely candidates due to their small size. The reptiles at LA 115260 could not be identified to either genus or species, but given the numerous species of reptiles inhabiting the Tularosa Basin (particularly lizards and snakes), it is likely that all or most of these remains are from desert floor species. These are all small animals and were marginal, opportunistic subsistence resources. Given the harsh conditions and fauna-poor resource base of the desert floor, however, post-Pleistocene peoples here may have pursued such marginal resources more regularly than peoples living in richer environmental zones (Dawson 1991:122).

Birds identified in the assemblages included quail and hawk. Two species of quail were identified at LA 115260: Montezuma quail and either Scaled or Gambel's quail. Both the scaled quail and Gambel's quail inhabit arid country and are found in desert brush and thickets. Montezuma quail, on the other hand, inhabit grassy and brush-covered ground in pine-oak woodlands. Scaled quail are sensitive to climatic changes, namely drought and heavy rains, and during extremely dry summers scaled quail do not breed. Both scaled quail and Gambel's quail need water holes for survival.

The *Buteo* species of hawks inhabit ecological niches that can be found adjacent to the Tularosa Basin as well as in the basin. From riparian to upland environments and the open grasslands in between, the hawk bone recovered from LA 6829 could have been acquired from any of these areas.

The desert floor supports both desert cottontail and black-tailed jackrabbit. Grasses, mesquite, bark, twigs, and cactus are chief foods for both. The cottontail has a home range of 6 ha (15 acres) for males and 4 ha (9 acres) for females, whereas jackrabbit will range up to 310 ha (768 acres). The smaller territory of the cottontail might be one reason for the infrequency of cottontail relative to jackrabbit in the faunal assemblages, as cottontails might have been more easily thinned or eradicated from an area as a result of hunting pressure. Cottontail also prefer a brushier environment than black-tailed jackrabbit, and are more frequently found in upland areas than the lower desert of the project area. The fact that they both compete for the same foods might result



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in the cottontail becoming more easily stressed during dry periods in the lowlands. Mating is year-round for both species, which makes it difficult to speculate on seasonality of acquisition.

The limited variety of rodents identified beyond Order are all at home in a desert environment, but are also found in biotic communities neighboring the desert floor. Most rodents identified for this project do not hibernate in the winter in the southern Tularosa Basin, but some estivate in the summer (a state of dormancy similar to hibernation). Heteromyidae (pocket mice and kangaroo rats) are neither mice nor rats but are genetically closer to ground squirrels and pocket gophers and are primarily nocturnal. None of the Cricetidae hibernate and most breed throughout the year. Mammologists have recently combined Cricetidae (New World Mice and Rats) with Muridae, which heretofore referred strictly to Old World Mice and Rats. Muridae now encompasses both families and is the preferred name (William Gannon, personal communication 2001).

The badger is in the Mustelidae family and does not hibernate. The fact that 13 bones identified to this species were recovered from LA 115260 suggests that one or more of these animals were taken close to the site, or that badgers burrowed on-site, with their remains subsequently re-distributed.

## Marine Shell Artifact

Only one marine shell artifact was recovered during excavation, a small shell disk bead from site LA 6829 (Figure 23.3). The disk bead measures .68 cm in diameter with a maximum thickness of .18 cm and central perforation diameter of .20 cm. It was crafted from a *Glycymeris gigantea* bivalve. The bead was recovered from Feature 54.2, a large posthole in Structure 1, the Late Doña Ana/early El Paso communal structure.

## Discussion

By far, the most frequently occurring animals at both LA 6829 and LA 115260 are jackrabbit, cottontail, and rodent. Reptile, bird, medium mammal, and large mammal occur in much lower frequencies. LA 115260 had more identified species but that is probably a result of a larger sample size, nearly ten times larger than LA 6829.

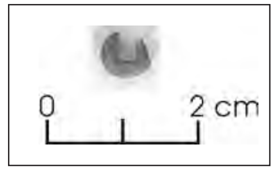


**Figure 23.3 A small shell disk bead from site LA 6829.**

Although the relative frequencies with which taxa occur at both sites are similar, there are dissimilarities in the frequencies of both lagomorph and artiodactyl (Table 23.11). Lagomorph accounts for 17.8 percent NISP at LA 6829, compared with 27.3 percent NISP at LA 115260, making identified lagomorph one and one-half times more frequent at LA 115260. Artiodactyl is over four times more frequent in terms of NISP at LA 6829 than at LA 115260 and is 11 percent of the biomass at LA 6829 compared with 0.2 percent biomass at LA 115260. These numbers could be a manifestation of the smaller sample size at LA 6829, resulting in an over-representation of artiodactyls at this site. However, four times the number of artiodactyl remains was found at LA 6829 than at LA 115260, and artiodactyl accounts for over ten times the amount of biomass at LA 6829 than at LA 115260. None of the artio-

**Table 23.11 Percentages of Taxa by NISP and Biomass**

| Taxon | %NISP | | % Biomass | |
|---|---|---|---|---|
| | LA 6829 | LA 115260 | LA 6829 | LA 115260 |
| Reptile | - | <0.1 | - | <0.1 |
| Bird | 1.5 | 0.4 | 2.5 | 0.3 |
| Lagomorph | 17.8 | 27.3 | 37.1 | 52.7 |
| Rodent | 0.9 | 3.4 | 0.6 | 2.3 |
| Carnivore | - | 0.5 | - | 3.3 |
| Artiodactyl | 0.4 | <0.1 | 11 | 0.2 |
| Bird/Small Mammal | 76.2 | 67.4 | 41.4 | 38.4 |
| UID Mammal | 2.3 | 0.8 | 7.4 | 2.6 |
| UID Bone | 0.9 | - | - | - |



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dactyl remains from either site exhibited use-wear, so their occurrence as part of a tool kit was discounted. The greater frequency of artiodactyl at LA 6829 could indicate variation in hunting strategy, namely the targeting of larger mammals by the Jaca site inhabitants.

Based on NISP, the ratio of jackrabbit to cottontail is 4:1 at LA 115260 and 3:1 at LA 6829. Ethnographic evidence indicates that communal hunting of jackrabbits with nets was an especially successful strategy for desert-floor groups in the American West, and certainly much more successful than trying to hunt these animals individually. Cottontail, in contrast, becomes elusive in heavy brush and is more successfully acquired by individual hunters. The different jackrabbit:cottontail ratios may suggest communal hunts were occurring more frequently at LA 115260 than at LA 6829. With the higher number of artiodactyl remains at LA 6829 and fewer jackrabbit relative to cottontail, perhaps the residents of this site employed more individual methods of hunting, as opposed to their counterparts at LA 115260. Cottontail might have been opportunistically obtained while hunting artiodactyl on a more individual, and less communal, basis. In any event, the inhabitants of both sites were heavily focused on lagomorphs for the meat portion of their diet.

The Turquoise Ridge site yielded a faunal assemblage very similar to those from LA 6829 and LA 115260 (Whalen 1994b:120). Of the 9,400 specimens analyzed from Turquoise Ridge, the predominant taxa were lagomorphs (88 percent of the specimens identified at least to class). Rodents contributed 8 percent, and amphibians, reptiles, birds, and *Carnivora* made up the remaining 4 percent. There was no identified artiodactyl in the sample. Of the rodents, 12 percent of their skeletal elements were burned indicating these animals were likely eaten. The entire assemblage was extensively fragmented, which is similar to the remains from LA 6829 and LA 115260.

It is possible that the bones at the Turquoise Ridge site, as well as those from LA 6829 and LA 115260, were pulverized for the purpose of extracting fats and oils. As described in ethnographic accounts (e.g., Binford 1978), bone pounded into small pieces maximizes surface area. Fragments are then boiled and the grease is skimmed off. Speth (1983) states that while rendering bone grease is labor intensive, it is one way to increase supplies of fat during seasons when animal meat is lean and also low in nutritional value. In the southern Tularosa Basin, the generally lean animal resource base may have encouraged potential prehistoric inhabitants to maximize the nutrient of game animals through such labor-intensive techniques.

The Gobernadora site, a Doña Ana-phase occupation (ca. A.D. 1100–1200) in the western Hueco Bolson near El Paso, Texas, also revealed a faunal assemblage similar to that at LA 6829 and LA 115260. Specifically, jackrabbit was the most common species represented, accounting for over 45 percent of NISP of 1,998 fragments, and cottontail was second in frequency with 11.5 percent NISP (Miller 1990). The residents of Gobernadora relied primarily on lagomorphs for the meat portion of their diet. The frequency of lagomorphs in the Gobernadora faunal assemblage is only slightly less than amounts recovered from Mesilla-phase sites excavated in the Hueco Bolson (Hard 1987, in Miller 1989:296). The proportions of animal species identified from Gobernadora, specifically the pronounced emphasis on lagomorphs with only an occasional procurement of deer and antelope, are consistent with a lowland hunting pattern similar to that described by O'Laughlin and Gerald (1977).

Much of the faunal and subsistence data for the southeastern quadrant of New Mexico surrounds the Pecos River Valley and the uplands east of the Tularosa Basin. Driver's (1985) study of faunal remains from six sites in the Sierra Blanca Region describes Ceramic-period meat procurement as including three components: hunting of small ani-



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mals, especially lagomorphs, in the immediate site vicinity; hunting of medium-sized animals farther afield; and acquisition of bison even farther away, either by hunting or by trade (Driver 1985:59–61). Driver concludes that hunting served largely to supply protein rather than fat for the prehistoric diet in this region.

Data from the Middle Pecos region show that large mammals, particularly bison, are being selected for in the thirteenth and fourteenth centuries (Sebastian and Larralde 1989). Wiseman (1985), however, demonstrates that fish, as well as bison, formed an important part of the diet at the Rocky Arroyo site in the Rio Hondo drainage. As a result of this work, Sebastian and Larralde (1989:81) suggest that riverine resources, particularly fish and mussels, have been underestimated in the prehistoric diet.

In the Los Esteros area of the Pecos River, Mobley (1979) found no evidence to suggest that Pueblo period subsistence differed from an Archaic hunting and gathering subsistence economy in his site sample. He suggests that during the Pueblo period, the Los Esteros area was occupied by hunters and gatherers who maintained a basically Archaic way of life but incorporated ceramics and the bow and arrow into their subsistence technology (Mobley 1979:220).

Similarities between the Archaic and Ceramic periods are illustrated in Mick-O'Hara's analyses of faunal remains from sites dating to A.D 225 (LA 58971) and A.D. 1200–1400 (LA 71167) in the upper Rio Hondo in southeastern New Mexico (Wiseman 1996:157–180). Faunal data from LA 58971 indicate an Archaic subsistence adaptation focusing on intense use of a wide variety of small mammals with occasional large mammal procurement. Desert cottontail comprised 23.3 percent of the sample while jackrabbit comprised 8.3 percent of the sample. Artiodactyl, including deer and pronghorn antelope, were 4.0 percent, and birds were only 0.4 percent of the total assemblage. Other than the black-tailed prairie dog (1.4 percent), all small mammal classifications (primarily rodents) each comprised less than 1 percent of the total assemblage. Faunal materials from the Glencoe phase (A.D. 1200–1400) at LA 71167 indicate a similar Archaic-like subsistence strategy although cottontail and jackrabbit decrease slightly in inverse proportion to an increase in large mammal and bird procurement (reflecting the upland environment in which the Glencoe phase is centered). Desert cottontail comprised 8.5 percent of the assemblage and jackrabbit was 2.9 percent. Artiodactyl, including deer, pronghorn antelope, and bison, accounted for 6.8 percent of the assemblage. All of the small mammals (primarily rodents) comprised less than 1 percent each. A variety of birds were identified (10 genera and species) but each was less than 1 percent of the total assemblage. Fish (catfish) comprised a little more than 1 percent. The higher frequency of large mammals and an increase in the variety of animals might be the result of LA 71167 having a longer-term occupation than LA 58971.

Applegarth (1976) argues that differences between Archaic and Ceramic periods are less pronounced in the Guadalupe Mountains east of the project area than in other areas. There, hunting and gathering remained the primary subsistence activity and agriculture was not adopted.

Although most of the sites and regions discussed here are adjacent to the southern Tularosa Basin in upland environments, and/or adjacent to more predictable water sources, these sites indicate subsistence strategies remaining relatively unchanged from the Archaic to Ceramic periods, with mobile populations relying very little on agriculture. Mobile populations frequenting the Tularosa Basin relied on highly localized resources that might have been less predictable within the basin floor, but they were surrounded by other regions that could be exploited during other seasons as well.

Late winter and early spring are times when most animals are at their leanest, and Speth (1983:157–158) suggests alternatives to compensate for the lack of protein from fat in the human diet during those lean times. Selective hunting might



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have included animals with high body fat such as beaver and geese or other migratory fowl. There is no evidence for these animals having been acquired at LA 6829 or LA 115260; indeed they probably were not present in the local area. There might have been an emphasis on plant gathering, rather than hunting, in the fall to build up a store of carbohydrates to offset the lack of fat in the diet come late winter and early spring. Limited cultivation or trading for carbohydrates with horticulturalists could have also served to augment the diet. Dried meat products, such as jerky or pemmican, may also have been acquired through trade, but would not have left any durable remains in the archaeological record.

The faunal remains examined for this project are typical of lowland sites where jackrabbit and cottontail dominate the assemblages. There does appear to have been a slightly greater focus on artiodactyl at LA 6829 than at LA 115260. This may or may not parallel the model of selecting for larger mammals in the thirteenth and fourteenth centuries along the Pecos River, and the occupation of LA 6829 does not appear to have extended beyond the early thirteenth century. Unfortunately, the faunal remains from this project do not include clear seasonal indicators, and so it is tenuous to infer seasonality from these remains alone. O'Laughlin and Martin (1993:190–191) argue that the occupation of the basin floor was principally during the warmer, biotically productive season of the year when water was available from rainfall. They further postulate that this pattern characterized populations of the middle Archaic to the Historic periods, with site attributes varying with intensity of occupation. The one attribute that appears to have stayed the same is the reliance on jackrabbit as the mainstay of meat subsistence in the southern Tularosa Basin.



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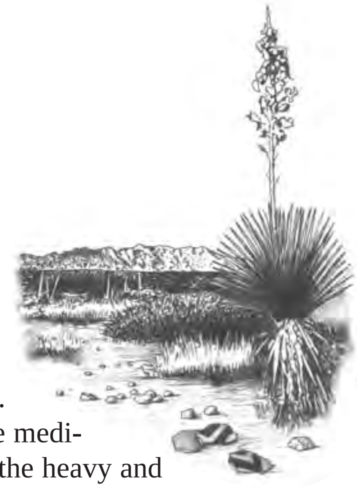
Chapter 24



# *Macrobotanical Remains*

*Thomas C. O'Laughlin*

The US 54 investigations recovered a large number of flotation samples and charcoal specimens, and this chapter reports the results of analyses on these materials. The samples and specimens come from the 11 data recovery sites: LA 6829, LA 115256, LA 115259, LA 115260, LA 115262, LA 115263, LA 115265, LA 126181, LA 128699, LA 128700, and LA 128708. These sites include the remains of Archaic and Formative period occupations and encompass both residential and task-specific locations. The botanical remains recovered from these sites provide an opportunity to investigate temporal patterns in resource utilization that include a consideration of local resources and cultigens.

## Methods

The TRC staff prepared the 101 flotation samples. The majority of flotation samples were processed employing a water flotation technique and a Flote-Tech machine described by Hunter and Gassner (1998). The flotation process was also monitored by the addition of 100 count poppy (*Papaver* sp) seeds to approximately one out of every 10 samples. Using water to remove fine clay and silt particles and float away lighter materials, the heavy fraction was first caught on a 1/16-inch mesh screen and then transferred to a 1/16-inch mesh fabric filter for final cleaning and drying. Water with the lighter, floating or suspended materials was passed through a 1/48-inch mesh fabric filter. This light fraction captured by the fabric filter was also cleaned and dried. After drying, the processed light and heavy fractions were placed in separate polyethylene bags. Soil sample volume and volumes of the light and heavy fractions were recorded.

Portions of four samples and all of a fifth were processed with buckets in an equivalent manner to that described above. Again, water was the medium used to separate the heavy and light fractions from soils. These fractions were combined with the light and heavy fractions isolated with the Flote-Tech machine.

Parts of eight samples were dry screened through 1/16-inch mesh. The fraction caught by the screen was added to the heavy fraction of flotation samples. The soil passing through the screen was discarded and not treated by water flotation. The intent of dry screening was to increase the amount of charcoal in the heavy fraction that could be used in radiocarbon dating.

The larger and easily retrieved pieces of charcoal were separated from the light and heavy fractions of flotation samples by the TRC staff. Indeed, very little charcoal remained in the heavy fractions. Weights were taken of these charcoal samples for potential radiocarbon dating.

Both the light and the heavy fractions were viewed at 10–30 power with a binocular microscope. Notes were taken of contaminates such as roots, rodent feces and insect parts. Burned and unburned seeds, charcoal and plant parts other than unburned roots were separated from the light fraction for identification. For the heavy fraction, an attempt was made to retrieve all remaining pieces of charcoal of a size that might permit identification. The light fractions contained more charcoal than the heavy fractions, and only the larger pieces were removed for identification. All of the heavy fractions were scanned for identifiable plant remains. However, only wood charcoal was retrieved from the heavy fractions. Light fractions were often of such a size that only a portion of them could be viewed. For these, the light fraction was thoroughly mixed prior to sampling



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for viewing, and volumes of viewed and unviewed portions recorded.

Charcoal retrieved from the flotation samples by the writer was snapped to reveal a fresh transverse section and viewed at 10–40 power for identification in comparison to reference specimens. Following the identification of 20 pieces of charcoal to characterize a sample, the remaining pieces were scanned to insure that other taxa were not present. Burned and unburned seeds and other plant parts from the light fractions were examined at 10–40 power and identified by comparison to reference specimens of the writer and standard published sources.

A total of 88 lots of macrobotanical and charcoal samples for potential radiocarbon dating was studied. The macrobotanical samples were cob fragments of corn (*Zea mays*) and some seeds that were recognized in the course of excavation. The charcoal samples included portions of two unburned juniper (*Juniperus* sp) posts from a structure, and 70 percent of the charcoal samples came from flotation samples. Identification of charcoal, seeds, and other plant parts was carried out according to the methods described for flotation samples. For charcoal, an attempt was made to identify at least 5 grams of a single taxa for radiocarbon dating purposes. The remaining material was then scanned for taxa that had not already been identified. Weight was recorded for all identified charcoal and the remaining, not-identified portion.

## Results

The source and attributes of each of the 101 flotation samples are presented in Appendix F (Table F-1). Most of the samples come from thermal features; however, a few structures and pits, a midden, and one burial are also represented. Sample volumes are large and range up to 37.5 liters. Only three samples have volumes of less than 4 liters. In spite of large sample volumes, the weights of charcoal tend to be moderate or light. Thirty-four percent of the samples have no measurable charcoal, and another 34 percent have less than 5 grams of charcoal. In general, the charcoal has a degraded or weathered appearance and consists of small fragments, with only a relatively few specimens exceeding 5 mm.

Modern contaminants recorded for the light fractions of flotation samples are listed in Appendix F (Table F-2). All samples show some contamination by roots, rodent and/or insect feces, and insect parts. A large majority of the samples also exhibit unburned seeds of plants common to lowland areas of the Chihuahuan Desert. Annuals and perennials that are conspicuous during the growing season are represented by amaranth (*Amaranthus* sp), purslane (*Portulaca* sp), spurge (*Euphorbia* sp), goosefoot (*Chenopodium* sp), Cheno-Am (either *Amaranthus* sp or *Chenopodium* sp), loco weed (*Astragalus* sp), puncture vine (*Tribulus terrestris*), spectacle pod (*Dithyrea wislizeni*), croton (*Croton* sp), cowpen daisy (*Verbesina encelioides*), prairie sunflower (*Helianthus petiolaris*), hairyseed bahia (*Bahia absinthifolia*), buckwheat (*Eriogonum* sp), blue phacelia (*Phacelia coerulea*), spiderling (*Boerhaavia* sp), stick-leaf (*Mentzelia* sp), trailing four-o'clock (*Allionia incarnata*), pepper-weed (*Lepidium* sp), tansy mustard (*Descurainia pinnata*), and warty kaltrop (*Kallstroemia parviflora*). Representing shrubs and leaf succulents native to the area are seeds and fruits of mesquite (*Prosopis glandulosa*), creosote bush (*Larrea tridentata*), four-wing saltbush (*Atriplex canescens*), and narrowleaf yucca (*Yucca elata*). Cacti include a few seeds of strawberry or pitaya cactus (*Echinocereus* sp). Grass cover is reduced in the region, but seeds of vine mesquite grass (*Panicum obtusum*), dropseed (*Sporobolus* sp), and possibly bluestem (*Andropogon* sp) were found. The presence of several seeds of clover (*Trifolium* sp) may reflect proximity of sites to US 54 where seeds may have been introduced and plants prospered in the road cuts. In addition to unburned seeds, the leaves of mesquite, four-wing saltbush, and creosote bush were observed in many of the light fractions.

The relative abundance of modern contaminants in the light fractions of the flotation samples and the small amounts of charcoal in many of the samples reflect that most of the features are at or near the surface, have been subjected to the elements, and have been impacted by bioturbation.

Poppy seeds were added to approximately one of every 10 flotation samples. For the last 40 samples in Appendix F (Table F-2), there are four samples with poppy seeds. Unfortunately, there is no record of the samples to which the seeds were added. However, the number with seeds is in the expected proportion. This is not so for the first 61 samples. Six of these samples were recorded to have had poppy seeds added to the samples, and these same six samples show the recovery of poppy seeds. In addition, there are another eight samples with poppy seeds. The numbers of poppy seeds in many of these latter samples are large enough to suggest that seeds may have been intentionally added to the samples without surviving notation. Then again, small numbers for several of the samples could be taken as an indication of cross contamination of the samples with use of the Flote-Tech machine. Recovery rate is also low; only five samples of the known or presumed samples with added poppy seeds exhibit a recovery rate of 25 percent or more, the highest being 81 percent.

Weights of charcoal extracted from flotation samples by the TRC staff are again provided in Appendix F (Table F-3), along with counts of identified taxa for charcoal remaining in either the light or heavy fractions of samples. For most samples, at least 20 identifications are reported. Samples with fewer than 20 identifications often have little or no charcoal, but this is not a strong correlation. The ability to identify charcoal is more dependent on the condition and size of charcoal than it is on abundance. Only two samples have no identifiable wood charcoal.

Of the 99 samples with identifiable charcoal, mesquite is the only identified taxon for 61 samples. Mesquite dominates another 29 samples, and occurs in lesser proportions in 97 of the samples. The second most common taxon is fourwing saltbush. Saltbush is present in 34 samples, is the only taxon identified in two samples, and dominates another six samples. Mesquite and saltbush are common elements of the Chihuahuan Desert, frequently can be found together, and are distributed from desert lowlands to lower elevations of mountains. These species are found in sites scattered throughout the project area from the basin floor to margins of the bajada surrounding the Jarilla Mountains. There are no strong temporal or spatial patterns in the representation of these species in the project sites. There is, however, a slight tendency for assemblages dominated by saltbush to be from sites located on or near the bajada of the Jarilla Mountains. Mesquite is ubiquitous and abundant in charcoal samples from lowland sites of the region and obviously a preferred fuel. Saltbush generally runs a distant second, with representation in samples presumably following local distribution of the species (see Cummings 1989, 1992; Minnis and Toll 1991; O'Laughlin 1980, 1988, 1994a, 1994b).

Creosote bush occurs in two samples from LA 6829. Creosote bush prefers gravelly soils and is a common element on alluvial fans around mountains. LA 6829 is on the toe of the Jarilla Mountains bajada, and creosote bush is found today in the immediate area. Creosote bush is not well represented in archaeological sites of the region and does not appear to have been a fuel held in much regard (Cummings 1989; O'Laughlin 1980, 1994a, 1994b).

Narrowleaf or soap tree yucca is widely distributed in lowland areas and can be relatively abundant in some locales. Charred pieces of the flowering stalk, probably of this species, were identified in three samples from thermal features at three different sites. These stalks are not a good indicator of season of occupation. They are produced from spring into the summer but can persist in a dry, woody form for several years. Yucca stalks and stalks of other leaf succulents were



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used occasionally for fuel and as elements for roofing structures (O'Laughlin 1995a, 2001a).

Juniper is identifiable in one sample from a structure on LA 6829. Although juniper does not occur on the basin floor, it has been found as a construction material for Pueblo period structures of the region (O'Laughlin 1995a, 2001a, field notes 1968–1970). Presumably, the juniper used in Feature 54 at LA 6829 came from the nearby Otero Mesa, as the Jarilla Mountains are too small and low to have supported many juniper in later prehistoric times.

Grass (Gramineae) stems were found in 21 samples from seven sites. Most of the samples are from LA 6829, LA 115260, and LA 115265 where preservation of carbonized plant remains is better than other sites Appendix F (Tables F-4 and F-5). There are no apparent temporal or spatial patterns in the representation of grass stems, and they were recovered from structures, pits, a midden, and thermal features indicating use as tinder or a fuel, and as a roofing element.

Carbonized cultigens and native plant seeds recovered from flotation samples are listed in Appendix F (Table F-4). Two patterns are readily apparent in the distribution of carbonized seeds and cultigens.

First, little to nothing was identified for 64 samples from sites LA 115256, LA 115259, LA 115262, LA 115263, LA 126181, Orogrande 1 (LA 128699), Orogrande 2 (LA 128700), and Orogrande North (LA 128708). Components at these sites range in age from the early Late Archaic Fresnal phase to the Doña Ana phase. Charred native seeds from these sites were found in only 11 samples, and include nine amaranth, three purslane, and one strawberry or pitaya cactus. Amaranth and purslane have edible greens and seeds available from late spring through the summer and are well represented in the archaeological record of the region. Similarly, pitaya has edible fruits that mature in the summer, and seeds of this plant are known from a number of archaeological sites (O'Laughlin 2001a; Wetterstrom 1978; Whalen 1994b). These samples and seeds come from sites that range in age from Late Archaic to middle Formative, and evidence from these components suggest limited or ephemeral occupation. The possible exceptions are Orogrande 1, which has structures and an intensive Late Archaic component, and LA 115262, which contains at least one early Mesilla phase pithouse.

The results for these sites may also indicate preservation factors, especially at sites such as Orogrande 1, which contained abundant features. The represented taxa may also suggest occupation during the summer. However, there are a number of factors that leave these interpretations open to question. The seeds of amaranth and purslane, and the dried fruits of pitaya, can be stored for extended periods, and, therefore, occupation could have occurred during seasons other than summer. Seeds of these taxa may have been burned as a direct result of subsistence activities, but they could just as easily have been burned as a result of their inclusion in tinder or presence in soils lining thermal features (Minnis 1981; Minnis and Toll 1991; O'Laughlin 1988, 1994a). It should be remembered that these and other taxa are common modern contaminants in the flotation samples and that they likely were common in soils in the past. These sites and samples are not unusual. Indeed, it is the rule that lowland sites of the Pithouse period or earlier will yield few carbonized seeds or cultigens and that interpretation is complicated by the paucity of plant remains other than wood charcoal (Dean 1994; Goldborer 1985; Holloway 1994; O'Laughlin 1980, 1988, 1994a, 1994b; Wetterstrom 1978; Whalen 1994b).

The second set of sites reflects a relative high species diversity and abundance of cultigens and native plant seeds. This pattern is discrerned from 37 samples from the Jaca site (LA 6829), LA 115260, and LA 115265. All three of these sites contain Doña Ana phase components, with the occupation at Jaca extending into the early El Paso phase. Fifteen different taxa are identifi-



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able in these samples, and all but one sample had burned native seeds and/or cultigens. Cultigens set these sites and samples apart from the first group. Corn kernels and/or cupules of cobs occur in 90 percent of the samples from LA 6829, both of the samples from LA 115265, and definitely two and probably four of the five samples from LA 115260. Within the region, similar high percentages of samples with corn are known only for late Doña Ana and El Paso phase residential sites, including both pueblos to pithouses (Duran and Batcho 1983; Cummings 1992; Foster *et al.* 1981; O'Laughlin 1985c, 1995a, 1995b, 2001a; O'Laughlin and Martin 1990). O'Laughlin (1985c, 1995a, 2001a) also records other cultigens, a diverse array of native plants, and relatively abundant carbonized plant remains for late Doña Ana and El Paso phase residential sites and notes that earlier residential sites exhibit less diverse assemblages and fewer carbonized plant remains, particularly cultigens. Again, sites LA 6829, LA 115260, and LA 115265 align themselves better with late residential sites than they do with sites similar to those of the first group.

Cultigens in addition to corn are noted only for Jaca (LA 6829). Bean (*Phaseolus* sp) cotyledon fragments were recovered from three flotation samples, and rind fragments of a cultivated gourd (*Lagenaria siceraria*) were found in another sample.

Samples from Jaca (LA 6829), LA 115260, and LA 115265 also contain seeds of edible native plants including amaranth, Cheno-Ams, purslane, dropseed, coyote melon (*Apodanthera undulata*), prairie sunflower and Indian rice grass (*Oryzopsis hymenoides*); seeds from the edible fruits of datil (*Yucca baccata*), pitaya and prickly pear (*Platy-Opuntia* sp); and the seeds and edible pods of mesquite. Greens of amaranth and purslane are available as early as late spring, most seed resources mature in summer to early fall, and datil and cacti fruits can be gathered from early to late summer. Warm season production of reproductive plant parts is characteristic of the Chihuahuan Desert, but the presence of seeds and fruits in these archaeological sites does not preclude occupation at other times of the year. As evidenced by the subsistence patterns of the Mescalero Apache, the abovementioned plants are important resources of the region and have excellent storage properties (Basehart 1974). All of the plants represented by burned seeds in these sites have wide lowland desert distributions, with the exception of datil. Datil is typically restricted to bajadas and low elevations of mountains and occurs around the Jarilla Mountains.

One other native plant is recorded for a sample from LA 6829. This is warty kaltrop. As an herb, this plant is apparently of some medicinal value (Moore 1979), and burned seeds have been found at one other Pueblo period site in the region (O'Laughlin 2001a).

Identified taxa for radiocarbon and macrobotanical samples are given by weight in Appendix F (Table F-5). The represented taxa, their relative importance, and distributions among the project sites mirror the results from flotation samples. Mesquite dominates the charred wood assemblage, occurs in 71 samples, is the only taxon in 44 samples, and dominates 26 mixed samples. Next in abundance is fourwing saltbush, which is found in 29 samples, is the only taxon in two samples, and dominates only one mixed sample. The third species is creosote bush, and like the flotation samples, creosote bush is noted for only a few radiocarbon samples and only from the Jaca site (LA 6829), which lies at the foot of the Jarilla Mountains bajada. The next woody taxon is juniper, which is a nonlocal species. Two samples are comprised of the unburned bases of juniper supports for a structure, Feature 54, at Jaca. Juniper was also identified in one of the flotation samples from this structure. Finally, one sample from Jaca contained a piece of probable narrowleaf yucca stalk, and grass stems were recovered from four samples representing three sites.

Among the macrobotanical samples are four datil seeds, one mesquite seed and one prickly pear seed from Jaca (LA 6829) and two datil seeds

from LA 115260. Common beans (Phaseolus cf vulgaris) come from two samples from Jaca (LA 6829), and 25 samples from Jaca and one from LA 115265 have corn cob fragments and/or kernel fragments. These macrobotanical samples follow flotation samples in that cultigens and these native plant taxa are noted only for the late Formative sites of Jaca (LA 6829), LA 115260, and LA 115265.

The macrobotanical samples of cultigens include a number of specimens that are large enough to provide more definite identification of the beans and some description of corn cobs and kernels. Common bean appears to be represented by specimens from Jaca (LA 6829), as two measurable cotyledons are 7.5 x 3.8 x 1.0 mm and 8.7 x 4.7 x 1.6 mm. These dimensions are well within the range of common bean. Measurements of cobs and kernels of corn are provided in Table 24.1 for site LA 6829. Measurements in this table have not been adjusted for shrinkage with burning. In general, specimens are weathered and reduced in size. A few specimens suggest somewhat long and indurated glumes for cobs. Row numbers tend to be low, and cupules broad and relatively narrow. Kernels are rounded and also fairly narrow. Eight-row corn and a Pueblo flour corn would appear to be represented. However, the evidence for corn types is rather limited.

## Discussion

Information has been provided on a large number of flotation samples from sites of differing age and intensity of occupation. It has been noted that processing of the samples with the Flote-Tech machine may have resulted in some cross contamination of samples and reduced efficiency of recovery of light fractions. Problems of this sort have been documented before (Rossen 1999). However, it should be observed that samples from the same site are similar to one another and that the greatest differences in recovered carbonized plant materials are between sites. Thus, cross contamination would appear to be inconsequential. Additionally, and though recovery of plant remains may not have been very efficient, it is possible to define a number of patterns in these materials. Flotation samples clearly illustrate these patterns that are not changed by a consideration of carbonized plant remains from macrobotanical and radiocarbon samples.

**Table 24.1 Data on Carbonized Maize Kernels Recovered from LA 6829**

| Site (LA) | PNUM | Feature No. | Zea mays Part | Row Number | Cupule Width (mm) | Cupule Thickness (mm) | Kernel Thickness (mm) |
|---|---|---|---|---|---|---|---|
| 6829 | 881 | 66 | cob | 8 | 6.5-7.3 | 3.2-3.4 | |
| 6829 | 882 | 66 | cob | 8 | 7.1-7.2 | 3.3-3.5 | |
| 6829 | 1090 | 88 | cob | | 4.5-7.5 | 3.6-4.2 | |
| 6829 | 1170 | 85 | cob | 10-12 | 6.3-7.2 | 3.3-4.1 | |
| 6829 | 1217 | 54.2 | cob | 12 | 4.9-5.4 | 3.3-4.2 | |
| 6829 | 1217 | 54.2 | kernel | 8-10 | | | 4.6 |
| 6829 | 1217 | 54.2 | kernels | | | | 3.8-4.1 |
| 6829 | 1561 | 120/156 | cob | 8 | 7.0-7.4 | 3.2-3.4 | |
| 6829 | 1575 | 54.13 | cob | 12 | 4.1-5.1 | 3.9-4.1 | |
| 6829 | 1585 | 142 | cob | | 6.3 | 3.3 | |
| 6829 | 1585 | 142 | kernel | | | | 4.8 |
| 6829 | 1724 | 82 | kernel | | | | 3.8 |
| 6829 | 1836 | 186 | cob | 10-12? | 8.0-8.1 | 3.4-3.6 | |
| 6829 | 1863 | 141 | cob | | 8.1-8.6 | 3.0-3.6 | |
| 6829 | 1868 | 137 | cob | 10? | 8.0 | 3.6 | |
| 6829 | 1868 | 137 | cob | 8 | 5.4 | 3.9 | |



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The floor of the Tularosa Basin has seen a considerable change in vegetation that began in the second half of the nineteenth century. Territorial survey records and historical accounts testify to a dramatic reduction in grass cover and increase in desert shrubs as a result of the combined effects of over grazing, drought, and other factors (O'Laughlin and Crawford 1977; McGuinnes and Goldman 1969). As recently as 1915, beans were dry farmed in the vicinity of Newman, near the New Mexico–Texas border (O'Laughlin 2001a). Today, this would be considered a feat of some magnitude in the project area with its lack of soil moisture, loss of soil, and unstable soil surfaces.

The shift from relatively good grass cover in the nineteenth century to desert shrub dominance in the twentieth century is not an isolated event. Throughout the Holocene, desert shrubs and grasses have varied inversely in their relative abundance with changes in effective precipitation (Freeman 1972; Horowitz *et al.* 1981; Van Devender and Spaulding 1979). From this, it could be advanced that the relative representation of shrubs and grasses in the archaeological record would reflect upon past environments. This, however, is not the case for lowland sites of the Jornada region and away from the Rio Grande (see Mauldin *et al.* 1998; Minnis and Toll 1991; O'Laughlin 1988, 1994a, 1994b). Mesquite charcoal is ubiquitous and dominates Archaic and later assemblages, owing in large part to its widespread distribution and in part to its preference as a fuel and element for superstructures of huts, pithouses, and pueblos. Saltbush is consistently represented but in numbers suggesting it was not a preferred fuel. Creosote bush is also represented but in very low numbers, even in bajada situations where it dominates the landscape today. Creosote bush was apparently not considered a good fuel wood. Other shrubs occur infrequently in samples and constitute only a minor and uninformative addition to assemblages. Grasses present a somewhat different picture from shrubs in that they are not well represented in the archaeological record, even though grass may have been used as tender or in shelter construction. This may be due to the fragile nature of grass stems and leaves and their degradation beyond recognition during excavation and/or the flotation process. In any event, it is a matter of record that charcoal from archaeological sites of the lowland Jornada region are biased towards an abundance of mesquite due to its obvious preference as a fuel and that charcoal samples show no temporal patterning in the relative abundance of shrubs and grasses.

In difference to the above position, it should be mentioned that oak has been identified in a few samples from lowland sites just north of the project area (Seaman 1988). The presence of oak in these samples has been taken as an indication of a more mesic basin environment in the past. However, these identifications have been questioned (Minnis and Toll 1991) and the issue remains unresolved.

Charcoal from flotation and radiocarbon samples of this project is as described above. Whether by number of samples, number of identifications or weight, mesquite is noticeably abundant in the samples from all sites. A distant second is saltbush that shows some tendency to be more common for sites on or near the bajada of the Jarilla Mountains. Creosote bush is poorly represented and is recorded only for the Jaca site (LA 6829), which lies on the toe of the bajada and where some creosote bush can be found today. Oak is not present in these samples, and a few pieces of narrow-leaf yucca stalk were observed. Grass stems occur in very small numbers and, like shrubs, show no temporal pattern.

The only taxon recovered from the flotation and radiocarbon samples that does not occur in the project area today is juniper. Construction elements of juniper were recovered from the late Formative period Structure 1-2 (Feature 54), at the Jaca site (LA 6829) and are reasoned as having come from Otero Mesa to the east. Juniper and cottonwood (*Populus fremontii*) posts and beams have been recovered from a number of lowland Pueblo period sites in the region and at



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some distance from potential sources (O'Laughlin 1995a, 2001a, field notes 1966–1970).

Burned native seeds and cultigens from this project exhibit two patterns that are shared by other lowland and open sites of the Jornada region. A paucity of burned native seeds and the absence or rare occurrence of cultigens characterizes the first pattern. The second is a reverse of the first; i.e., ubiquitous occurrence of cultigens and native seeds.

Task specific and residential sites of the Pithouse and Archaic periods and ephemeral sites of unknown period typically have yielded a low percentage of flotation samples with carbonized native seeds and cultigens and numerically few specimens (see Mauldin *et al.* 1998; Minnis and Toll 1991; O'Laughlin 1980, 1988, 1994a, 1994b; Wetterstrom 1978). For this project, the results are somewhat mixed in relation to this prevailing pattern in the region. There are 64 samples from eight sites that produced 13 burned seeds in 11 samples. These eight sites include task specific and residential locations that range from the Late Archaic period to the Doña Ana phase. But included here are the three Orogrande sites (LA 128699, LA 128700, and LA 128708), which after Jaca (LA 6829) were the most prolific sites archaeologically in the US 54 data recovery project.

The few burned seeds in samples from this group of sites make interpretation difficult, problematic, and easily questioned. Burning of these seeds may have been incidental to any subsistence activity and at a time other than when they were produced. The presence of unburned and modern seeds in most flotation samples begs the possibility of accidental burning because of their presence in soils in the past. The three represented taxa also have durable seeds or fruits and their use could have been extended into seasons other than when they were produced. A simple but unverifiable interpretation would hold that these remains represent procurement and subsistence activities minimally related to amaranth, purslane, and pitaya at these locations sometime between late spring and late summer.

For the region, low recovery rates and small numbers of burned native seeds and cultigens have been attributed to the small size of flotation samples, exposed and weathered features with poor preservation, and low-intensity use of features and relatively mobile populations (see Mauldin *et al.* 1998; Minnis and Toll 1991; O'Laughlin 1988, 1994a, 1995a, 2001a). As noted for sites of this project, evidence of bioturbation and the presence of unburned seeds would indicate shallow depths and likely exposure of many features. Thus, poor preservation could be a contributing factor for the low recovery of burned native seeds. Flotation samples of this project are, however, much larger than the standard one or two liter sample and, even so, have produced few burned native seeds. The remaining factor of residential mobility, combined with low intensity of feature use, has the greatest explanatory potential (despite the relatively large numbers of features at the Orogrande sites), especially when these sites are contrasted with those exhibiting the second pattern of relative abundance of burned native seeds and cultigens.

Sites LA 6829, LA 115260, and LA 115265 illustrate a class of sites where burned native plant seeds and cultigens are relatively abundant and where a diverse range of native plant resources are represented. These sites date to the Doña Ana and early El Paso phases. Thirty-six of the 37 flotation samples from these sites have burned native seeds and/or cultigens, and only these sites produced these remains. Twelve taxa of native seeds are identifiable, and these represent resources within the vicinity of these sites. Seeds or dried fruits of these taxa also have excellent storage properties, and they do not necessarily delimit season of occupation. They would, however, have been available at various times from spring to fall. Native plant resources represented at these sites compare well with those described for the Mescalero Apache, whose historic territory included the project area (Basehart 1974). Three cultigens are recorded and include corn, common

bean, and cultivated gourd. As with the native plant taxa, corn and beans can be stored and could have extended occupation to multiple seasons or year-round. Maize cob and kernel fragments occur in high percentages of samples from these sites.

Within the Jornada region, the diversity of native plants and cultigens observed at sites LA 6829, LA 115260, and LA 115265 is replicated only at larger residential sites of the Mesilla phase and small and large residential sites of the Doña Ana and El Paso phases. However, the diversity of taxa and the high frequency of samples with burned native seeds-and particularly cultigens-is not the same for all of these sites. The larger Mesilla phase residential sites may have a diverse representation of plant resources but few flotation samples contain burned specimens and fewer than 25 percent have yielded cultigens (Goldborer 1985; Wetterstrom 1978; Whalen 1994b). Sites LA 6829, LA 115260, and LA 115265 and other Doña Ana and El Paso phase residential sites show not only a high diversity of native seed plants and cultigens, but also generally high ubiquity of these remains as well, along with high frequencies of maize remains (Cummings 1989, 1992; Duran and Batcho 1983; Foster *et al.* 1981; O'Laughlin 1985c, 1995a, 1995b, 2001a; O'Laughlin and Martin 1990). Jaca (LA 6829), LA 115260, and LA 115265 all follow this latter pattern, and all three contain Doña Ana components. Interestingly, however, among the first group of US 54 sites (i.e., those showing low frequency and ubiquity of native seed plants, and an absence of maize) are two Doña Ana components (LA 126181 and LA 128700). Based on the macrobotanical assemblages, it would appear that these occupations were perhaps less intensive (and/or more task-specific) than were those at the three Doña Ana-dominated sites that contain abundant and ubiquitous native seeds and maize remains. The implication here is that Doña Ana settlement and subsistence patterns involved a diversity of strategies, perhaps involving marked seasonality and/or notable variation in economic patterns among different local groups.

At any rate, it is suggested that the floral assemblages from Jaca (LA 6829), LA 115260, and LA 115265, all dominated by Doña Ana-phase occupation remains (and including early El Paso phase remains at Jaca), are reflecting a regional pattern of reduced residential mobility, longer and more intensive occupations of residential sites, a differential treatment and greater accumulation of trash with concomitant greater preservation of burned plant remains, and possibly a greater dependence upon cultigens. As such, these sites are very important in helping define the timing and conditions of this transition from the Pithouse period to the El Paso phase.



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Chapter 25

# Pollen Remains

John G. Jones

## Introduction

The analysis of fossil pollen from archaeological sediments can provide a wealth of data. Information on the regional paleoenvironment can be gained through the careful analysis of changes in pollen floral composition in well-dated sediment. Evidence of prehistoric subsistence patterns as well as agricultural practices and specific crops can be gained from these types of studies. The analysis of feature fill can also provide insights into past feature function, food preparation and storage activities. Through a detailed analysis of pollen samples from the US 54 Project, it was anticipated that these types of information might be obtained.

A total of 59 sediment samples was examined for fossil pollen. These samples were collected from a variety of features at seven archaeological sites, and represent a range of dates (see Table 25.1). In addition to these sediments, a single pollen wash from a ground stone artifact was also examined.

The sites from which the samples were collected all lie in the Chihuahuan Biotic Province, although local edaphic factors influence the composition of specific floral communities in the immediate site areas. Generally speaking, the local flora is dominated by creosote bush (*Larrea tridentata*), joint fir (*Ephedra*), saltbush or shadscale (*Atriplex* sp.), tarbush (*Flourensia cernua*), snakeweed (*Xanthocephalum*), mesquite (*Prosopis*), sages (*Artemisia* sp.), grasses, yucca (*Yucca* sp.) and prickly pear (*Opuntia* sp.). Additional taxa that are found in more mesic locations include cottonwood (*Populus*), willow (*Salix*), oak (*Quercus*) and sumac (*Rhus*). It is highly likely that the modern vegetation in the vicinity of these archaeological sites is not representative of the flora found in the area when these sites were occupied. Land clearing by early settlers, as well as overgrazing by livestock, has seriously altered the face of much of the region. The accidental, as well as deliberate, introduction of non-native flora has led to the artificial replacement of many species. Finally, the overcollecting of native succulents, particularly members of the Cactaceae (cactus) family has led to the decimation and near extinction of many species. Thus pollen studies are often important in helping to establish lists of ancient flora in a region.

## Methodology

Fossil pollen preservation from archaeological sites in the southeastern New Mexico region is variable. Exposure to cycles of wetting and drying can lead to rapid deterioration of organic materials, including pollen. These problems are particularly exacerbated in alkaline regions, where high pH values frequently signal a nearly complete loss of fossil pollen grains from buried soils. As such, a conservative extraction technique was employed with the US 54 pollen samples.

The pollen samples were first quantified (generally 10–30 mls), placed in sterile beakers, and a known quantity of exotic tracer spores was added to each sample. Here, European *Lycopodium* sp. spores were chosen as an exotic because these spores are unlikely to be found in the actual fossil pollen assemblages from this region. Tracer spores are added to samples for two reasons. First, by adding a known quantity of exotic spores to a known quantity of sediment, fossil pollen concentration values can be calculated. Second, in the event that no fossil pollen is observed in the sediment sample, the presence of *Lycopodium* tracer spores verifies that processor error was not a factor in the pollen loss.



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Table 25.1 Proveniences of the US 54 Pollen Samples

| Sample | Site | PNUM | Feature No. | Feature Type |
|---|---|---|---|---|
| 1 | 128699 | 316 | 3 | Basin Thermal Feature |
| 2 | 128699 | 567 | 25 | Circular Basin Thermal Feature |
| 3 | 128699 | 386 | 20 | Circular Thermal Feature |
| 4 | 128699 | 494 | 23 | Sub-rectangular Pithouse Feature |
| 5 | 128699 | 493 | 26 | Sub-rectangular Pithouse Thermal Feature |
| 6 | 128699 | 546 | 33 | Roasting Pit |
| 7 | 128699 | 529 | 81 | Oval Basin Thermal Feature |
| 8 | 128699 | 581 | 43 | "Hut" Pithouse Structure |
| 9 | 128699 | 517 | 79 | Circular Thermal Feature |
| 10 | 128699 | 488 | 38 | Oval Basin Thermal Feature |
| 11 | 128699 | 557 | 70 | Oval Basin Thermal Feature |
| 12 | 128699 | 486 | 78 | Irregular/Oval Thermal Feature |
| 13 | 128699 | 620 | 102 | Oval Basin Thermal Feature |
| 14 | 128699 | 621 | 104 | Oval Basin Thermal Feature |
| 15 | 128700 | 677 | 33 | Oval Basin Thermal Feature |
| 16 | 128700 | 738 | 38 | Oval Basin Thermal Feature |
| 17 | 128700 | 746 | 29 | Roasting Pit |
| 18 | 128700 | 814 | 35 | Oval Basin Thermal Feature |
| 19 | 128700 | 818 | 43 | Circular Basin Thermal Feature |
| 20 | 128708 | 66 | 2 | Roasting Pit |
| 21 | 128708 | 81 | 39 | Roasting Pit |
| 22 | 128708 | 93 | 41 | Oval Basin Thermal Feature |
| 23 | 128708 | 97 | 42.01 | Small pit within Thermal Feature |
| 24 | 128708 | 87 | 45 | Oval Basin Thermal feature |
| 25 | 6829 | 691 | 62 | Circular Thermal Feature |
| 26 | 6829 | 999 | 38 | Oval Basin Structure |
| 27 | 6829 | 1090 | 88 | Oval Irregular Pit, Hueco |
| 28 | 6829 | 1216 | 54.04 | Plaster-Lined, Circular Thermal Feature |
| 29 | 6829 | 1280 | 58 | Oval Basin Pit, Hueco |

**Table 25.1 Proveniences of the US 54 Pollen Samples (continued)**

| Sample | Site | PNUM | Feature No. | Feature Type |
|---|---|---|---|---|
| 30 | 6829 | 1358 | 82 | Irregular Pit, Hueco |
| 31 | 6829 | 1377 | 118 | Oval Basin Pit |
| 32 | 6829 | 1382 | 119 | Oval Basin Structure |
| 33 | 6829 | 1411 | 120 | Irregular Pit, Hueco |
| 34 | 6829 | 1460 | 163 | Oval Irregular Pit |
| 35 | 6829 | 1608 | 54.16 | Circular Pit |
| 36 | 6829 | 1626 | 174 | Oval Pit |
| 37 | 6829 | 1630 | 54.22 | Structure 2 |
| 38 | 6829 | 1663 | 89 | Oval Clay-Lined Pit |
| 39 | 6829 | 1683 | 17.01 | Oval Pit, Covered by Bowl |
| 40 | 6829 | 1692 | 178 | Circular Basin Thermal Feature |
| 41 | 6829 | 1708 | 146 | Structure 15, Irregular |
| 42 | 6829 | 1711 | 111 | Structure 13, Sub-rectangular |
| 43 | 6829 | 1733 | 185 | Oval Basin Thermal Feature |
| 44 | 6829 | 1748 | 147 | Irregular Oval Pit |
| 45 | 6829 | 1802 | 79 | Structure 7, Irregular |
| 46 | 6829 | 1808 | 186 | Structure 17, Oval |
| 47 | 6829 | 1813 | 116 | Irregular Pit, Hueco |
| 48 | 6829 | 1822 | 138 | Bell-Shaped Circular Pit |
| 49 | 6829 | 1826 | 179 | Structure 11, Oval |
| 50 | 115260 | 125 | 1 | Midden, Level 2 |
| 51 | 115260 | 127 | 1 | Midden, Level 3 |
| 52 | 115260 | 289 | 7 | Irregular Oval Pit |
| 53 | 115260 | 323 | 1A | Oval Borrow pit |
| 54 | 115262 | 190 | 35 | Circular Basin Thermal Feature |
| 55 | 126181 | 118 | 4 | Circular Basin Thermal Feature |
| 56 | 126181 | 120 | 7 | Circular Basin Thermal Feature |
| 57 | Control Sample | | Historic Sands | |
| 58 | 6829 | 1170 | 85 | Circular Basin Thermal Feature |
| 59 | 6829 | 888 | | Mano, Pollen Wash |

Following the addition of the tracer spores, the samples were washed with concentrated Hydrochloric Acid. This step removed carbonates and dissolved the bonding agent in the tracer spore tablets. The samples were then rinsed in distilled water, sieved through 150-micron mesh screens, and swirled to remove the heavier inorganic particles. Next the samples were consolidated, and 60 percent Hydrofluoric Acid was added to the residues to remove unwanted silicates. After the silicates had been removed, the residues were rinsed thoroughly and sonicated in a Delta D-5 sonicator for 30 seconds. This step deflocculated the residues, effectively removing all colloidal material smaller than two microns.

Next, the samples were dehydrated in Glacial Acetic Acid, and were subjected to an acetolysis treatment (Erdtman 1960) consisting of nine parts Acetic Anhydride to one part concentrated Sulfuric Acid. During this process, the samples were placed in a heating block for a period not exceeding eight minutes. This step removed most unwanted organic materials, including cellulose, hemi-cellulose, lipids, and proteins and converted these materials to water-soluble humates. The samples were then rinsed in distilled water until a neutral pH was achieved.

Following this treatment, the samples were next subjected to a heavy density separation using Zinc Bromide (Sp.G. 2.00). Here, the lighter organic fraction was isolated from the heavier minerals. After this treatment, the lighter pollen and organic remains were collected and washed in 1 percent KOH to remove any remaining humates. The residues were then dehydrated in absolute alcohol and transferred to a glycerine medium for curation in glass vials.

A single pollen wash from site LA 6829 was also prepared. Here, pollen from the grinding surface of a mano was carefully washed into a beaker using a series of distilled water and dilute Hydrochloric Acid washes. Tracer spores were added to the sample to verify processing, but as a known volume of sediment was not collected, concentration values could not be calculated. Sediments were next screened, rinsed, treated with Hydrofluoric Acid, a weak alkali wash in Potassium Hydroxide (1 percent), an acetolysis treatment, and a heavy density treatment. The pollen residue was then transferred to glycerine for analysis and curation.

Permanent slides were prepared using glycerine, and identifications were made on a Jenaval compound stereomicroscope at 400–1000x magnification. Identifications were confirmed by using the Palynology Laboratory's extensive pollen reference collection. A minimum of 200 fossil grains was counted for each sample. This number is considered standard among most palynologists (Barkeley 1934) and is thought to reflect past vegetation fairly well.

Concentration values were calculated for all samples. Hall (1981) and Bryant and Hall (1993) note that concentration values below 1000–2,500 grains/ml of sediment may not be well reflective of past conditions. Samples with concentration values lower than these standards may still be valuable for providing a list of vegetation in the region. However, one must remember that the pollen counts obtained probably reflect a differentially preserved assemblage and that the pollen recovered and identified may be quite different than the assemblage that was originally integrated into the sediments at the time of site occupation. As a result, fossil pollen counts with low concentration values should be viewed with caution.

## Results

As a whole, pollen from sites in the US 54 area was not well preserved. Cycles of wetting and drying of the sediments has led to extreme oxidizing conditions in the region. As a result, pollen concentration values, although variable, were generally fairly low, though it was possible to obtain 200-grain counts in 51 of the 59 samples. Eight samples did not contain enough fossil pollen to allow a count to be made, of which seven samples came from site LA 128699, a Jornada Mogollon



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campsite, indicating that this site likely experienced the greatest degree of oxidation/degradation. A number of samples with very low concentration values were counted for this study. Recognizing that these assemblages may not accurately reflect past conditions at the sites, the data are still valuable as listings of species once present in the site area.

## Pollen Taxa

A total of 44 different plant taxa (see Table 25.2) are represented by pollen from the US 54 samples, including 31 different non-arboreal and 13 arboreal taxa.

## Apiaceae

Pollen from members of the parsley family was rarely noted in the sediment samples. These plants favor moist environments including swales and sides of streams. A number of mostly Old World economic plants are represented by this family, but here, the presence of Apiaceae pollen is probably accidental. Members of this family are insect-pollinated, and its pollen is infrequently encountered in archaeological sediments.

## *Artemisia*

Pollen from *Artemisia*, or sage, was a significant component of most of the pollen samples from the US 54 project. A number of species of *Artemisia* are documented in the project area. These grains are generally quite thick and in harsh environments tend to be better preserved than thinner grains. Thus, an abundance of *Artemisia* grains may sometimes signal that differential preservation of fossil grains has occurred. Although generally pollinated by insects, sages are also facultatively wind pollinated, and some sage pollen is to be expected in sediments from this region.

## Asteraceae

Pollen grains from the Asteraceae or Compositae family are unusually polymorphic, and can usually be placed into categories based on their diagnostic morphologies. Low spine Asteraceae pollen

**Table 25.2 Pollen Taxa Identified in the US 54 Sediment Samples**

| Taxa | Common Name |
|---|---|
| **Non-Arboreal** | |
| *Apiaceae* | Parsley Family |
| *Artemisia* | Sagebrush |
| High Spine Asteraceae | Sunflower Group |
| Low Spine Asteraceae | Ragweed Group |
| *Cirsium*-type Asteraceae | Thistle |
| *Liguliflorae*-type Asteraceae | Dandelion Group |
| *Boerhaavia*-type | Spiderling |
| Brassicaceae | Mustard Family |
| Cheno-Am | Goosefoot, pigweed, Shadscale |
| *Cylindropuntia* | Cholla Cactus |
| Cyperaceae | Sedge Family |
| *Echinocereus* | Hedgehog Cactus |
| *Ephedra nevadensis*-type | Joint Fir, Mormon Tea |
| *Ephedra torreyana*-type | Joint Fir, Mormon Tea |
| *Eriogonum* | Desert Buckwheat |
| Fabaceae | Bean Family |
| Gentianaceae | Gentian Family |
| Lamiaceae | Mint Family |
| Liliaceae | Lily Family |
| *Mirabilis*-type | Four O'clock |
| *Platyopuntia* | Prickly Pear Cactus |
| Poaceae | Grass Family |
| Polemoniaceae | Phlox Family |
| Polygonaceae | Knotweed Family |
| *Portulaca* | Purslane |
| Rosaceae | Rose Family |
| Sphaeralcea | Globe Mallow |
| *Typha angustifolia* | Narrowleaf Cattail |
| *Vitis* | Grape |
| *Yucca* | Yucca |
| *Zea mays* | Maize |
| **Arboreal** | |
| *Acacia* | Acacia |
| *Alnus* | Alder |
| *Carya* | Hickory, Pecan |
| *Dalea* | Dalea |
| *Juniperus* | Juniper |
| *Pinus edulis*-type | Pinyon Pine |
| *Pinus ponderosa*-type | Ponderosa Pine |
| *Prosopis* | Mesquite |
| *Prunus* | Cherry |
| *Quercus* | Oak |
| *Rhus* | Sumac, Poison Ivy |
| *Salix* | Willow |
| *Tamarix* | Salt Cedar |
| Indeterminate | Too Poorly Preserved to Identify |



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grains are types possessing relatively short spines on the grain surface. These types are generally wind-pollinated and are among the most abundant and durable types encountered in southwestern sediment samples. This group includes ragweed, goldenrod, and snakeweed. High spine Asteraceae, on the other hand, displays higher exine spines and is usually insect pollinated. Thus, these grains are usually uncommon in archaeological samples. An important member of this group is sunflower. Based on the diagnostic thick exine, and short thick spines, *Cirsium*, or thistle type, can usually be separated from other members of the Asteraceae Family. These grains, like most members of the Asteraceae Family, are very durable and pollen from this group may be over-represented in poorly preserved assemblages. Liguliflorae-type Asteraceae grains are readily distinguished by their echinate, fenestrate morphology. Members of this group include dandelion and chicory. As a whole, Asteraceae pollen is usually well represented in southwestern pollen samples due to its abundance and durability.

### *Boerhaavia* and *Mirabilis*-type

Pollen grains from the Nyctaginaceae (Evening Primrose Family) can be separated into two types based on their distinctive surface ornamentation: *Boerhaavia* (spiderling) and *Mirabilis* (Four O'clock) types. These types are large, durable, and readily recognizable. Thus despite the fact that they are insect-pollinated and ordinarily rare, they tend to be over-represented in Southwestern pollen assemblages.

### Brassicaceae

Pollen from the Brassicaceae or Mustard Family is fairly diagnostic but usually an uncommon component of southwestern pollen assemblages. As a number of economically important members of this family are known, the occurrence of this grain may signal the past use of one of these plants. Economic members of this family include *Lepidium* (peppergrass) and *Descurainia* (tansy-mustard), and the introduced *Brassica* (cabbage, cauliflower, broccoli, mustard, and rapeseed), *Raphanus* (raddish) and *Rorippa* (water cress).

### Cheno-Ams

The category Cheno-Am is made up of pollen from the family Chenopodiaceae, and the genus *Amaranthus* in the family Amaranthaceae. These grains are among the most commonly encountered pollen taxa in the southwest, as they are produced in abundance, are durable, and are diagnostic even when highly degraded. Some common members of the Chenopodiaceae family include *Chenopodium* (goosefoot), *Atriplex* (shadscale or saltbush), *Suaeda* (seepweed), *Sarcobatus* (greasewood), and *Allenrolfea* (pickleweed). Normally, greasewood and pickleweed pollen can be separated from other members of the family based on diagnostic features of the grains. A number of economic species are known from the Cheno-Am group, and Moerman (1998) notes the importance of *Chenopodium* fruit and *Amaranthus* seeds for both a food and medicine throughout the southwestern region. As these plants often favor waste places or disturbed habitats, they tend to occur naturally around habitation sites, and these plants were likely to have been encouraged by the prehistoric inhabitants of this region. However, it is difficult to establish a prehistoric use of these plants based on pollen, especially in poorly preserved sediments.

### *Cylindropuntia*, *Platyopuntia* and *Echinocereus*

Pollen from the Cactaceae Family is polymorphic, and a number of pollen types diagnostic to the genus, sub-genus, and even species level are known. Pollen from the genus *Opuntia*, if well preserved, can usually be separated into the subgenera *Platyopuntia* (the prickly pears) and *Cylindropuntia* (the chollas). These grains are generally rare in archaeological samples despite the relative abundance of the plants, because the grains are heavy and rarely travel far from the plant and are produced in low numbers. However, the grains are fairly durable and easily recognized,



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even when somewhat degraded, and as they represent important economic plants, tend to show up in archaeological deposits with some frequency. *Echinocereus* (hedgehog or strawberry cactus) also produces diagnostic grains. The presence of these grains in archaeological deposits may indicate a past economic usage of this plant.

### Cyperaceae

Pollen from the sedge family is readily recognizable, but is rarely preserved, as it tends to be somewhat fragile. The presence of sedge pollen in southwestern assemblages usually indicates the past presence of semi-permanent water in the region, such as a playa or streamside.

### *Ephedra*

Pollen from the woody Gymnosperm *Ephedra* (joint fir or Mormon tea) is produced in large numbers and is readily recognizable even when degraded, and thus tends to be common in southwestern archaeological sediments. This pollen type can usually be separated into two distinctive types: *E. nevadensis* and *E. torreyana*. Portions of many species of *Ephedra* have been used both as a food and a medicine, but documenting such use from pollen is difficult as the grains are common and disperse over great distances.

### Polygonaceae and *Eriogonum*

Members of the Polygonaceae (knotweed) family are usually fairly well represented in southwestern pollen assemblages. These grains are fairly common, durable, and are easily recognized unless degraded. Native American populations have used both *Polygonum* and *Rumex* as food and medicine (Moerman 1998). *Eriogonum* (desert buckwheat) has also been widely used as a food and medicine, and high percentages of Polygonaceae or *Eriogonum* pollen may signal a past economic usage.

### Fabaceae

Pollen from the bean or legume family is fairly common in archaeological sediments; however, unless perfectly preserved, they frequently cannot be identified beyond the family level. This is one of the largest plant families and these grains may represent hundreds of different species.

### Gentianaceae

Gentian pollen is rare in archaeological deposits in the southwest and probably represents the accidental inclusion of grains from a member of this family.

### Lamiaceae

Pollen from the mint family is usually recognizable due to its characteristic morphology. Members of the mint family generally prefer mesic environments, rather than the harsh xeric environment of the project area. While a number of economic members of this family are known, the relative scarcity of this pollen type argues against past economic usage.

### Liliaceae and *Yucca*

Pollen from the Liliaceae (lily) family is an uncommon but regular component of southwestern pollen assemblages. A number of economic plants are represented in this family, including *Allium* (onion), *Camassia* (camas), *Nolina* (bear grass), and *Dasylirion* (sotol). Under optimal conditions, it is possible to identify a number of genera in this family. However, due to the degraded condition of many of the US 54 project grains, identifications below the family level were not made. Pollen from *Yucca*, an important economic member of this family, does possess diagnostic features that usually allow for its identification. Moerman (1998) reports that *Yucca* fruit, flowers, stems, and roots have all been used in the southwestern United States for food, medicine, or other uses. As *Yucca* is insect pollinated, and its pollen rarely travels from the plant, it would not be expected to occur in archaeological sediment samples unless brought into the site area by the ancient inhabitants.



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## Poaceae and *Zea mays*

Pollen from the grass family is among the most common pollen types in the US 54 project samples. Grass pollen is produced in large quantities and is widely dispersed by the wind over great distances. While a number of economic grass species are known from the southwest including *Sporobolus* (dropseed), *Hordeum* (little barley), and *Oryzopsis* (ricegrass), these taxa cannot be identified from the pollen record. However, the presence of high percentages of grass pollen in specific cultural contexts may hint at the ancient use of this important plant family. *Zea mays* (corn or maize) can be readily separated from other grasses due to its large size and distinctive intertectile columnella. This tropical domesticate was introduced into the southwestern United States prior to 1000 B.C. (Wills and Huckell 1994) and rapidly became a central crop throughout much of the United States. As *Zea* is not native to the United States, the presence of this diagnostic grain demonstrates the use, if not the cultivation, of this important plant.

## Polemoniaceae

Pollen from the phlox family is rare in pollen samples from this region and probably represents a non-economic species. Members of this family include *Phlox* and *Gilia*.

## *Portulaca*

Pollen from purslane is uncommon in archaeological sediments and may represent an economic usage. Moerman (1998) reports that purslane leaves were eaten both raw and cooked, and that the plant had numerous medicinal qualities.

## Rosaceae

Pollen from the rose family is insect pollinated and infrequently encountered in archaeological deposits in the Southwest since it is produced in low numbers and is relatively fragile. Thus the presence of Rosaceae pollen, especially in higher percentages, may be indicative of past economic plant use. A number of economic genera are recorded in the rose family, including *Prunus* (plum or cherry), *Amelanchier* (serviceberry), *Crataegus* (hawthorn), *Fragaria* (strawberry), *Rubus* (blackberry, raspberry), and *Rosa* (rose).

## *Sphaeralcea*

Pollen from globe mallow is a fairly common component of southwestern pollen assemblages. Moerman (1998) reports that this plant has been used as both a food and medicine throughout the western United States. The grain is fairly durable and easily recognizable, but is produced in low numbers. The presence of more than a few of these grains in a sample may indicate a past economic use of this genus.

## *Typha angustifolia*

Pollen from cattail can usually be separated into the two common North American species: *Typha angustifolia* (narrowleaf cattail) and *T. latifolia* (broadleaf or common cattail). Grains found in the US 54 project samples were all from narrowleaf cattail. Cattail is wind pollinated and is produced in fairly large numbers. It is, however, fragile and would only be expected in pollen samples that exhibit very good preservation. The presence of high percentages of cattail might well indicate a past economic use of this important plant. Typha has a number of documented ethnographic uses including its use as a food, for fiber in making basketry, paint, and building material, and for ceremonial and religious purposes (Moerman 1998).

## *Vitis*

Pollen from grape is infrequently encountered in most archaeological samples as the grains are dispersed by insects and produced in low numbers. The presence of grape pollen may signal an economic use of this plant, although at the time grapes are harvested, little pollen is likely to have been present on the plant. Still, the presence of grape pollen is significant as it indicates that grapes were present in the site vicinity in the past and may have been an important seasonal resource.



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### *Acacia*

Despite the abundance of *Acacia* (huisache, black brush, catclaw) in the Chihuahuan Desert and the project area, *Acacia* pollen is rare in the pollen record. Produced in low numbers and disseminated solely by insects, pollen from this plant rarely finds its way into archaeological sediment samples unless it was bought into the site by human activity or the plant was growing in the immediate site area. The presence of *Acacia* pollen in the samples probably reflects natural rather than cultural activity.

### *Alnus*

Alder pollen is produced in large numbers and travels readily on the wind. Favoring mesic and montane conditions, the presence of diagnostic alder grains in the samples probably represents long distance transport from a distant montane source.

### *Carya*

Hickory, or pecan pollen, is a common component of eastern United States pollen assemblages. The natural range of *Carya* does not extend west of the Devil's River in west central Texas, and pecan pollen would not be expected in archaeological sediments from the project area. Pecans are currently under cultivation near the project area, and these trees are the likely source of the *Carya* pollen in the US 54 pollen samples.

### *Dalea*

*Dalea* is a common woody shrub, frequent in the southwest and in the project area. This plant is insect pollinated, and its pollen is rarely found far from the plant. The presence of *Dalea* pollen in the sediment samples is probably natural rather than cultural.

### *Juniperus*

Juniper is a prolific pollen producer, and its small pollen grains often travel great distances. Juniper is uncommon in the immediate project area, although it is present in nearby montane regions. High percentages of juniper pollen were noted in the US 54 samples. Juniper pollen, because of its abundance and relative durability, is often over-represented in poorly preserved southwestern pollen assemblages.

### *Pinus*

Pine pollen grains are usually a major component of pollen assemblages from the Southwest. Pine grains are produced in large numbers, they are readily dispersed over great distances by the wind, they are fairly durable, and they are easy to recognize even when highly degraded. Thus, pine tends to be over-represented in poorly preserved pollen assemblages. Based on diagnostic surface features, the pine pollen grains from the US 54 project have been separated into two distinct types: *Pinus edulis* (piñon pine) and *P. ponderosa* (ponderosa pine). However, any of these grains could have come from another species of pine. As pine produces pollen in the spring, while piñon nuts are harvests in the fall, a high percentage of piñon-type pollen cannot be correlated with the use of this important economic plant.

### *Prosopis*

Pollen from mesquite is generally considered to be fairly fragile and is easily eroded or degraded. The *Prosopis* pollen identified in the US 54 sediment samples all came from shallow samples or features, and probably represents essentially modern pollen grains.

### *Prunus*

Pollen from plum or cherry is uncommon in the project samples. These grains are produced in fairly low numbers by plants and are insect-pollinated. As a result, few grains disperse far from their source. In the Southwest, *Prunus* is restricted to mesic and montane environments. The presence of *Prunus* pollen in the US 54 project samples probably indicates either intrusive modern grains or a past economic use of this important plant.

### *Quercus*

Pollen from oak is a common component of archaeological sediments throughout North America, as the pollen is abundant, widely dispersed, readily recognizable, and fairly durable. Much of the oak pollen in the US 54 project samples is likely blowing in from both nearby and distant montane sources.

### *Rhus*

Pollen from sumac or poison ivy is uncommon in southwestern sediments. The pollen is easily recognized but is produced in fairly low numbers by plants and is dispersed by insects. As a result, little *Rhus* pollen is likely to occur in archaeological sediments unless it was deliberately brought into the site area. While poison oak or ivy may not have been a desirable plant, several species of sumac were widely used by native populations as a food and medicine, as well as a dye source (Moerman 1998). In the US 54 project samples, the presence of *Rhus* pollen likely signals a past economic use of this plant.

### *Salix*

Pollen from willow is produced in fairly large numbers and is dispersed by the wind. As such, it is a fairly common pollen type. However, it is fairly fragile and degrades rapidly in oxidized sediments. Willows prefer stream or lake margins, and the presence of large numbers of willow grains signals a permanently wet, semi-aquatic habitat. A few grains, however, might be expected to blow from a streamside setting into sediments some distance from this type of habitat.

### *Tamarix*

Pollen from *Tamarix* or salt cedar, was rarely encountered in the US 54 pollen samples. This plant was introduced from the Old World and has become a serious pest throughout the southwestern United States. The plant favors sides of streams and wet environments. The presence of pollen from this plant indicates that the sample is either modern or contaminated with modern pollen.

### *Indeterminate*

Indeterminate grains are those that are too poorly preserved to identify. These grains may be folded, crumpled, broken, or eroded. Hall (1981) and Bryant *et al.* (1994) have noted a correlation between the relative frequency of indeterminate fossil pollen grains and the concentration value of the samples. Samples with lower concentration values had higher numbers of indeterminate grains.

## Discussion of Species Represented in the Assemblage

A number of pollen taxa from the southwestern United States are frequently over-represented in fossil pollen assemblages, especially when some degradation of pollen has occurred in a particular area. Included in this group are Poaceae grains, low spine Asteraceae, Cheno-Ams, *Ephedra*, *Juniperus*, and *Pinus*. These taxa are all produced in very large numbers by plants and are all readily dispersed by the winds. As a result, these grains can travel great distances and obscure the local pollen flora. Further, these pollen types all have distinctive morphologies making them easily recognizable. Their durability means that they will be preserved longer than more fragile grains. These more durable taxa tend to be over-represented when degradation by oxidation has occurred at a particular locality, and palynologists must consider these factors when drawing interpretations.

Two taxa encountered in the US 54 samples represent modern intrusive species: *Carya* and *Tamarix*. The presence of these taxa demonstrates that the samples are either modern or that some form of mixing of sediments has occurred.

## Results of Analysis

A single modern surface pollen sample was collected in the project area, and it was felt that this sample might be fairly reflective of most of the site environments. Counts and percentages from this sample are presented in Table 25.3.

**Table 25.3 Pollen Counts and Percentages from a Modern Surface Sample**

| Taxa | Sample 57 | |
|---|---|---|
| | Count | Percent |
| *Apiaceae* | | |
| *Artemisia* | 5 | 2.5 |
| High Spine Asteraceae | | |
| Low Spine Asteraceae | 62 | 31 |
| *Cirsium* | | |
| Liguliflorae | | |
| *Boerhaavia*-type | | |
| *Brassicaceae* | 2 | 1 |
| Cheno-Am | 42 | 21 |
| *Cylindropuntia* | | |
| *Echinocereus* | | |
| *Ephedra nevadensis* | | |
| *Ephedra torreyana* | | |
| *Eriogonum* | | |
| Fabaceae | 1 | 0.5 |
| Gentianaceae | | |
| Lamiaceae | | |
| Liliaceae | | |
| *Mirabilis*-type | | |
| *Platyopuntia* | | |
| Poaceae | 21 | 10.5 |
| Polemoniaceae | 1 | 0.5 |
| Polygonaceae | 1 | 0.5 |
| *Portulaca* | | |
| Rosaceae | | |
| *Sphaeralcea* | | |
| *Typha* | | |
| *Vitis* | | |
| *Yucca* | | |
| *Zea mays* | | |
| *Acacia* | | |
| *Alnus* | | |
| *Carya* | 1 | 0.5 |
| *Dalea* | | |
| *Juniperus* | 28 | 14 |
| *Pinus edulis-type* | 12 | 6 |
| *Pinus ponderosa*-type | 2 | 1 |
| *Prosopis* | 7 | 3.5 |
| *Prunus* | | |
| *Quercus* | 11 | 5.5 |
| *Rhus* | | |
| *Salix* | | |
| *Tamarix* | | |
| Indeterminate | 4 | 2 |
| **Total** | **200** | **100** |
| Concentration Value (Grains/ml) | 7826 | |

**Sample 57**

The modern surface sample is dominated by pollen from low spine Asteraceae, Cheno-Ams, Poaceae, *Juniperus*, and *Pinus*. These taxa all tend to be over-represented in southwestern pollen samples as the grains are abundant, durable, and readily recognizable even when degraded. Other taxa noted in the samples include *Artemisia*, Brassicaceae, Fabaceae, Polemoniaceae, Polygonaceae, *Carya*, *Prosopis*, and *Quercus*. *Carya* is certainly a modern taxon, reflecting the nearby cultivation of pecan (*Carya illinoensis*). The nearest natural occurrence of this plant is in central Texas. *Prosopis* is another plant that occurs only in modern samples. While it is likely that mesquite was present in the site area in the past, pollen grains from this plant are fairly fragile and are most likely to be preserved in modern or unusually well-preserved ancient pollen assemblages.

A number of taxa noted in the modern surface sample are usually present in higher percentages in the archaeological sediment samples, including *Artemisia*, low spine Asteraceae, and Cheno-Ams. These grains are all extremely durable and possess unique morphologies, allowing for their ready identification even after the grains have been eroded.

## LA 6829 (Jaca Site)

Site LA 6829, the Jaca site, is a large residential site dating from the Doña Ana phase to early El Paso phase. In terms of pollen, this is the best-studied site in the project area, with a total of 27 pollen samples. Vegetation in the site vicinity includes mesquite, saltbush, snakeweed, grasses, yucca, prickly pear, and creosote bush.

Pollen samples were collected from a variety of features (see Table 25.1), including thermal features; round, oval, bell-shaped, and irregular basin pits; clay-lined pits; and structure floor fill; along with a pollen wash from a mano. Preservation of pollen in the LA 6829 archaeological samples was variable, but generally good, with concentration values of 829–7,200 grains/ml of sediment. As a



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known volume of sediment was not used in processing the mano pollen wash, a concentration value for this sample could not be calculated. Two-hundred-grain pollen counts were obtained for all of the samples from site LA 6829, and counts and percentages are presented in Table 25.4.

Grains from low spine Asteraceae, Cheno-Ams, Poaceae, and *Juniperus* dominated the Jaca site pollen samples. These taxa tend to be over-represented in southwestern pollen assemblages due to their abundance, durability, and easy recognition (even when highly degraded). Other taxa noted in the assemblages include Apiaceae, *Artemisia*, high spine Asteraceae, *Cirsium*, Liguliflorae, *Boerhaavia* and *Mirabilis*-type Nyctaginaceae, Cyperaceae, *Ephedra*, Fabaceae, Lamiaceae, Liliaceae, Polemoniaceae, Polygonaceae, *Sphaeralcea*, *Alnus*, *Dalea*, *Pinus*, *Prosopis*, *Quercus*, and *Salix*. Most of these taxa represent species that are commonly encountered in southwestern pollen samples and should be viewed as natural components of the regional pollen rain.

Possible economic types were fairly common in the Jaca sites samples and are represented by grains from Brassicaceae, *Cylindropuntia* and *Platyopuntia*, *Eriogonum*, *Portulaca, Typha*, *Yucca, Prunus, Rhus,* and *Zea mays*. Brassicaceae pollen was, in fact, fairly common in the LA 6829 samples, occurring in 20 of the 27 samples, although its frequency never exceeded 3 percent. Normally, Brassicaceae pollen is scarce in pollen samples from the Southwest, and substantial numbers of these grains may signal past economic uses of a member of this family. Similarly, *Eriogonum* occurred in 17 of samples from this site, although it never was found in frequencies greater than 1.5 percent. While both Brassicaceae and *Eriogonum* may represent economic taxa, the low number of grains found in any sample argues against their being used economically at this site.

The prehistoric utilization of *Opuntia* is indicated by the presence of both sub-genera: *Cylindropuntia* (the cola cactuses) and *Platyopuntia* (the prickly pear cactuses). Both types were found in two samples, although only in low frequencies. These pollen types are heavy and are produced in low numbers. The presence of pollen from these plants suggests that they were probably collected and utilized at the site in the past. Prickly pear and cholla fruits, buds, and joints were a common food source for native populations in the Southwest (Moerman 1998). Despite the size and thickness of these diagnostic pollen grains, they are relatively fragile and easily degraded; thus this plant is probably under-represented in the pollen record from the project area.

*Portulaca*, a normally rare grain, was noted in two of the LA 6829 samples, in one case represented by four (2 percent) grains. Leaves of purslane were consumed as a food, and the plant has numerous medicinal qualities (Moerman 1998). The presence of this pollen type, especially when it is represented by four grains, strongly suggests that this plant was being employed at the site in the past. This sample represents fill from an oval basin pit.

*Typha* was recorded in two samples from the Jaca site, though it was represented by only one- and two-grain occurrences. As cattail has so many documented uses for food, basketry, and ceremonial purposes, it seems likely that this plant was important to the ancient site inhabitants. The pollen of *Typha*, however, is fragile and unless the samples are particularly well preserved, its pollen would not be expected to survive. The presence of *Typha* pollen in the Jaca site sediments hints that this plant may have been an important economic component to the region’s prehistoric inhabitants.

*Yucca* is a common component of the flora of southeastern New Mexico, including the project area. *Yucca* pollen, however, is conspicuously absent from all sites except LA 6829, where it occurs in five samples, each marked by a single grain occurrence. The various parts of *Yucca* have a number of economic uses, including food, medicine, and soap, and this plant was surely an

**Table 25.4a Pollen Counts and Percentages from Site LA 6829, Samples 25–33**

| | Sample Numbers | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Taxa** | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **32** | **33** |
| Apiaceae | | | | | | | | | |
| *Artemisia* | 8 (4.0) | 9 (4.5) | 8 (4.0) | 1 (0.5) | 5 (2.5) | 6 (3.0) | 13 (6.5) | 6 (3.0) | 8 (4.0) |
| High Spine Asteraceae | 1 (0.5) | 3 (1.5) | 1 (0.5) | | 1 (0.5) | 4 (2.0) | 1 (0.5) | 1 (0.5) | 5 (2.5) |
| Low Spine Asteraceae | 40 (20.0) | 29 (14.5) | 21 (10.5) | 16 (8.0) | 44 (22.0) | 77 (38.5) | 33 (16.5) | 65 (32.5) | 60 (30.0) |
| *Cirsium* | | 1 (0.5) | 1 (0.5) | | 1 (0.5) | | 2 (1.0) | 2 (1.0) | 1 (0.5) |
| Liguliflorae | | | | 1 (0.5) | | | | 1 (0.5) | |
| *Boerhaavia*-type | | | | 1 (0.5) | 1 (0.5) | | 2 (1.0) | | |
| Brassicaceae | 1 (0.5) | 4 (2.0) | | | | 5 (2.5) | 2 (1.0) | 1 (0.5) | 2 (1.0) |
| Cheno-Am | 117 (58.5) | 125 (62.5) | 80 (40.0) | 159 (79.5) | 99 (49.5) | 67 (33.5) | 104 (52.0) | 63 (31.5) | 83 (41.5) |
| *Cylindropuntia* | | | 1 (0.5) | | | | | | |
| Cyperaceae | | 1 (0.5) | | | | | | | |
| *Echinocereus* | | | | | | | | | |
| *Ephedra nevadensis* | | | | 2 (1.0) | | | 1 (0.5) | 2 (1.0) | 2 (1.0) |
| *Ephedra torreyana* | | | 1 (0.5) | | | | | | |
| *Eriogonum* | | 3 (1.5) | 1 (0.5) | 1 (0.5) | 1 (0.5) | | 1 (0.5) | | 1 (0.5) |
| Fabaceae | 1 (0.5) | | 1 (0.5) | | | 1 (0.5) | | | 2 (1.0) |
| Gentianaceae | | | | | | | | | |
| Lamiaceae | | | | | | | | | |
| Liliaceae | | | | | | | | | 1 (0.5) |
| *Mirabilis*-type | | | | | | | | | |
| *Platyopuntia* | | | | | | | | | |
| Poaceae | 10 (5.0) | 7 (3.5) | 16 (8.0) | 4 (2.0) | 12 (6.0) | 18 (9.0) | 6 (3.0) | 24 (12.0) | 12 (6.0) |
| Polemoniaceae | | | | | | | 1 (0.5) | | |
| Polygonaceae | 1 (0.5) | | 2 (1.0) | | | | 1 (0.5) | 1 (0.5) | |
| *Portulaca* | | | 1 (0.5) | | | | 4 (2.0) | | |
| Rosaceae | | | | | | | | | |
| *Sphaeralcea* | 1 (0.5) | | 1 (0.5) | 1 (0.5) | 2 (1.0) | 1 (0.5) | | 1 (0.5) | 2 (1.0) |
| *Typha* | | | 4 (2.0) | | | | | | |
| *Vitis* | | | | | | | | | |
| *Yucca* | | 1 (0.5) | | 1 (0.5) | | | | | 1 (0.5) |
| *Zea mays* | | 1 (0.5) | 28 (14.0) | 1 (0.5) | | | | | |
| *Acacia* | | | | | | | | | |
| *Alnus* | | | | | | | | 1 (0.5) | |
| *Carya* | | | | | | | | | |
| *Dalea* | | | 1 (0.5) | | | | | | |
| *Juniperus* | 10 (5.0) | 4 (2.0) | 19 (9.5) | 6 (3.0) | 16 (8.0) | 7 (3.5) | 13 (6.5) | 14 (7.0) | 11 (5.5) |
| *Pinus edulis*-type | 3 (1.0) | 3 (1.5) | 9 (4.5) | 5 (2.5) | 6 (3.0) | 7 (3.5) | 10 (5.0) | 9 (4.5) | 4 (2.0) |
| *Pinus ponderosa*-type | | | 1 (0.5) | | | 1 (0.5) | | | |
| *Prosopis* | | | | | | | | | |
| *Prunus* | | | | | | | | | |
| *Quercus* | 1 (0.5) | 2 (1.0) | 1 (0.5) | | 5 (2.5) | 2 (1.0) | | 5 (2.5) | 1 (0.5) |
| *Rhus* | | | | | | | | | |
| *Salix* | 1 (0.5) | | 1 (0.5) | | | | | | |
| *Tamarix* | | | | | | | | | |
| Indeterminate | 5 (2.5) | 7 (3.5) | 2 (1.0) | 1 (0.5) | 7 (3.5) | 4 (2.0) | 6 (3.0) | 4 (2.0) | 4 (2.0) |
| **Total** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** |
| Concentration Value (Grains/ml) | 3484 | 2571 | 5192 | 6667 | 3462 | 6207 | 4500 | 951 | 2621 |



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**Table 25.4b Pollen Counts and Percentages from Site LA 6829, Samples 34–42**

| Taxa | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 |
|---|---|---|---|---|---|---|---|---|---|
| Apiaceae | | | | | | | | | |
| *Artemisia* | 5 (2.5) | 8 (4.0) | 8 (4.0) | 12 (6.0) | 6 (3.0) | 5 (2.5) | 10 (5.0) | 10 (5.0) | 10 (5.0) |
| High Spine Asteraceae | 1 (0.5) | 2 (1.0) | 3 (1.5) | 1 (0.5) | 4 (2.0) | 3 (1.5) | | 1 (0.5) | 1 (0.5) |
| Low Spine Asteraceae | 54 (27.0) | 24 (12.0) | 52 (26.0) | 41 (20.5) | 56 (28.0) | 14 (7.0) | 27 (13.5) | 33 (16.5) | 43 (21.5) |
| *Cirsium* | 2 (1.0) | | 1 (0.5) | 1 (0.5) | 1 (0.5) | 2 (1.0) | 1 (0.5) | | 1 (0.5) |
| Liguliflorae | 1 (0.5) | | | | 1 (0.5) | | | | |
| *Boerhaavia*-type | | | 1 (0.5) | 1 (0.5) | | | | 3 (1.5) | 1 (0.5) |
| Brassicaceae | 1 (0.5) | | 1 (0.5) | 2 (1.0) | 1 (0.5) | 6 (3.0) | 3 (1.5) | 1 (0.5) | 1 (0.5) |
| Cheno-Am | 102 (51.0) | 129 (64.5) | 80 (40.0) | 99 (49.5) | 78 (39.0) | 138 (69.0) | 104 (52.0) | 119 (59.5) | 97 (48.5) |
| *Cylindropuntia* | | | | | | | | | |
| Cyperaceae | | | | | | | | | |
| *Echinocereus* | | | | | | | | | |
| *Ephedra nevadensis* | 1 (0.5) | | 1 (0.5) | | | | | | 2 (1.0) |
| *Ephedra torreyana* | | | | | | | 1 (0.5) | | |
| *Eriogonum* | 1 (0.5) | | | 1 (0.5) | 1 (0.5) | 2 (1.0) | 1 (0.5) | 1 (0.5) | 1 (0.5) |
| Fabaceae | | 1 (0.5) | | | | | 1 (0.5) | | |
| Gentianaceae | | | | | | | | | |
| Lamiaceae | | | | | | | | | |
| Liliaceae | | | | | | | | | 2 (1.0) |
| *Mirabilis*-type | | | | 1 (0.5) | | | | | |
| *Platyopuntia* | | 1 (0.5) | | | | 3 (1.5) | | | |
| Poaceae | 10 (5.0) | 12 (6.0) | 21 (10.5) | 12 (6.0) | 22 (11.0) | 10 (5.0) | 14 (7.0) | 10 (5.0) | 15 (7.5) |
| Polemoniaceae | | | | | | | | | |
| Polygonaceae | 1 (0.5) | | | | 2 (1.0) | 1 (0.5) | 1 (0.5) | | |
| *Portulaca* | | | | | | | | | |
| Rosaceae | | | | | | | | | |
| *Sphaeralcea* | | 2 (1.0) | 4 (2.0) | 1 (0.5) | | | 1 (0.5) | | |
| *Typha* | 1 (0.5) | | | | | | | | |
| *Vitis* | | | | | | | | | |
| *Yucca* | | 1 (0.5) | | | | | 1 (0.5) | | |
| *Zea mays* | | | | | | | 1 (0.5) | | |
| *Acacia* | | | | | | | | | |
| *Alnus* | | | | | | | | | |
| *Carya* | | | | | | | | | |
| *Dalea* | | | | | | | | | |
| *Juniperus* | 8 (4.0) | 15 (7.5) | 18 (9.0) | 14 (7.0) | 21 (10.5) | 8 (4.0) | 13 (6.5) | 8 (4.0) | 10 (5.0) |
| *Pinus edulis*-type | 8 (4.0) | 1 (0.5) | 5 (2.5) | 7 (3.5) | 1 (0.5) | 3 (1.5) | 11 (5.5) | 5 (2.5) | 5 (2.5) |
| *Pinus ponderosa*-type | | 1 (0.5) | | | | 1 (0.5) | | | |
| *Prosopis* | | | | 1 (0.5) | | | | | |
| *Prunus* | | | | | | | | | 1 (0.5) |
| *Quercus* | 1 (0.5) | 1 (0.5) | 2 (1.0) | 1 (0.5) | 1 (0.5) | 2 (1.0) | 1 (0.5) | 2 (1.0) | 3 (1.5) |
| *Rhus* | | | | | | | | | |
| *Salix* | 2 (1.0) | 1 (0.5) | | 1 (0.5) | | | | | 1 (0.5) |
| *Tamarix* | | | | | | | | | |
| Indeterminate | 1 (0.5) | 1 (0.5) | 3 (1.5) | 5 (2.5) | 4 (2.0) | 2 (1.0) | 9 (4.5) | 7 (3.5) | 6 (3.0) |
| **Total** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** |
| Concentration Value (Grains/ml) | 3776 | 5400 | 1295 | 2584 | 1241 | 5047 | 2571 | 1964 | 1759 |



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**Table 25.4c Pollen Counts and Percentages from Site LA6829, Samples 43–49, 58, and 59**

| Taxa | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 58 | 59 |
|---|---|---|---|---|---|---|---|---|---|
| Apiaceae | | | 1 (0.5) | | | | | | |
| *Artemisia* | 9 (4.5) | 9 (4.5) | 9 (4.5) | 7 (3.5) | 9 (4.5) | 7 (3.5) | 6 (3.0) | 11 (5.5) | 9 (4.5) |
| High Spine Asteraceae | | | 1 (0.5) | 2 (1.0) | | 1 (0.5) | 1 (0.5) | 3 (1.5) | 1 (0.5) |
| Low Spine Asteraceae | 18 (9.0) | 44 (22.0) | 34 (17.0) | 31 (15.5) | 54 (27.0) | 51 (25.5) | 38 (19.0) | 55 (27.5) | 34 (17.0) |
| *Cirsium* | 1 (0.5) | | 1 (0.5) | 1 (0.5) | 3 (1.5) | | 1 (0.5) | | |
| Liguliflorae | | | | 1 (0.5) | | 1 (0.5) | 1 (0.5) | | |
| *Boerhaavia*-type | | | | | | | 1 (0.5) | | |
| Brassicaceae | | 1 (0.5) | 5 (2.5) | 2 (1.0) | 1 (0.5) | 3 (1.5) | 2 (1.0) | | |
| Cheno-Am | 133 (66.5) | 104 (52.0) | 114 (57.0) | 116 (58.0) | 68 (34.0) | 90 (45.0) | 123 (61.5) | 88 (44.0) | 104 (52.0) |
| *Cylindropuntia* | 1 (0.5) | | | | | | | | |
| Cyperaceae | | | | | | | | | |
| *Echinocereus* | | | | | | | | | |
| *Ephedra nevadensis* | 1 (0.5) | 1 (0.5) | | | | 1 (0.5) | | 1 (0.5) | 1 (0.5) |
| *Ephedra torreyana* | | | | | | | | | |
| *Eriogonum* | | | | 1 (0.5) | 1 (0.5) | | 2 (1.0) | 1 (0.5) | |
| Fabaceae | | | | | | | | | 1 (0.5) |
| Gentianaceae | | | | | | | | | |
| Lamiaceae | | | | | | | | 1 (0.5) | |
| Liliaceae | 1 (0.5) | | | | | | 1 (0.5) | | |
| *Mirabilis*-type | | 1 (0.5) | | | | | | | |
| *Platyopuntia* | | | | | | | | | |
| Poaceae | 15 (7.5) | 12 (6.0) | 10 (5.0) | 19 (9.5) | 27 (13.5) | 13 (6.5) | 5 (2.5) | 10 (5.0) | 18 (9.0) |
| Polemoniaceae | | 1 (0.5) | | | | | | | |
| Polygonaceae | 1 (0.5) | | 1 (0.5) | | 3 (1.5) | 1 (0.5) | | | |
| *Portulaca* | | | | | | | | | |
| Rosaceae | | | | | | | | | |
| *Sphaeralcea* | | 2 (1.0) | | | 1 (0.5) | | | 2 (1.0) | |
| *Typha* | | | | | | | | | |
| *Vitis* | | | | | | | | | |
| *Yucca* | | | | | | | | | |
| *Zea mays* | | 1 (0.5) | 2 (1.0) | 1 (0.5) | | | | 3 (1.5) | |
| *Acacia* | | | | | | | | | |
| *Alnus* | | | | | | | | | |
| *Carya* | | | | | | | | | |
| *Dalea* | | | | | | | | | |
| *Juniperus* | 7 (3.5) | 11 (5.5) | 8 (4.0) | 7 (3.5) | 16 (8.0) | 21 (10.5) | 11 (5.5) | 11 (5.5) | 23 (11.5) |
| *Pinus edulis*-type | 5 (2.5) | 4 (2.0) | 10 (5.0) | 9 (4.5) | 7 (3.5) | 7 (3.5) | 2 (1.0) | 9 (4.5) | 3 (1.5) |
| *Pinus ponderosa*-type | 1 (0.5) | 1 (0.5) | | | | | | 1 (0.5) | |
| *Prosopis* | | | | | 1 (0.5) | 2 (1.0) | | | |
| *Prunus* | | | | | | | | | |
| *Quercus* | 3 (1.5) | | 1 (0.5) | 1 (0.5) | 2 (1.0) | | 1 (0.5) | 2 (1.0) | 2 (1.0) |
| *Rhus* | | 1 (0.5) | | | | | 1 (0.5) | | |
| *Salix* | | | | | | | | | |
| *Tamarix* | | | | | | | | | |
| Indeterminate | 4 (2.0) | 7 (3.5) | 3 (1.5) | 2 (1.0) | 7 (3.5) | 2 (1.0) | 4 (2.0) | 2 (1.0) | 4 (2.0) |
| **Total** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** |
| Concentration Value (Grains/ml) | 2935 | 2338 | 4186 | 7200 | 3313 | 2093 | 5000 | 829 | *** |



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important part of the local economy. Pollen from *Yucca* is generally scarce in the pollen record as the grains are produced in low numbers and the pollen rarely travels from the flower, except via its pollinator, the Yucca Moth. Additionally, the pollen from *Yucca* is fairly fragile and its grains rarely are preserved in pollen samples that have been exposed to oxidation. Thus, like the cactuses, the presence of *Yucca* in small amounts probably hints at a more widespread use of this important economic plant.

A single *Prunus* pollen grain was noted in one sample from site LA 6829. *Prunus* pollen is generally scarce in southwestern samples as it is produced in low numbers and rarely travels far from its source. As *Prunus* is found in more mesic riverine and montane settings in this region, the occurrence of its pollen in samples is noteworthy. Thus even a single grain occurrence may be indicative of the prehistoric use of this important plant.

*Rhus* pollen was noted in two samples, each marked by the presence of a single grain. While the low percentage of *Rhus* pollen does not allow for the conclusion that this plant was definitely employed at the site, this occurrence demonstrates that it was present in the site area in the past. As *Rhus* has several important economic uses, including use as food, medicine, and for dye (Moerman 1998), it seems likely that the ancient inhabitants of this region utilized this plant.

*Zea mays* is the only domesticated plant identified in the pollen assemblages from the US 54 project, and its occurrence is restricted to site LA 6829. Maize pollen was noted in eight samples from the Jaca site, in percentages as high as 14 percent. *Zea* is one of the few grasses that can be positively identified by its pollen; however, its pollen is dispersed by both wind and insects and because of its large size, rarely travels any distance from the plant. Most maize pollen found in archaeological sediment has presumably been brought into the site area through human activity, but small amounts of pollen may blow into the site from nearby fields. Thus the presence of low quantities of maize pollen may signal only the nearby cultivation of maize, but larger quantities may be indicative of processing or storage.

Pollen assemblages from several archaeological features at site LA 6829 are noteworthy. Feature 88 (pollen sample 27) is an oval, irregular pit or *hueco*. Pollen was well preserved in this feature and the concentration value was 5,192 grains/ml. The good preservation was evident in the pollen record as a number of fragile grain types were identified. Pollen in fill from this feature also contained several possible economic species including *Cylindropuntia*, *Eriogonum*, *Portulaca*, and *Typha*. Most notable, however, was the high percentage of maize pollen (14 percent), suggesting that this feature may have been used for storage or food preparation, or that processing of maize occurred in the immediate vicinity.

Pollen sample 39 represents fill from Feature 17.1, an oval pit covered with a bowl, located inside a pithouse. Again, this sample exhibits better than average preservation, with a concentration value of 5,047 grains/ml. In addition to the potential economic taxa Brassicaceae and *Eriogonum*, this assemblage also contained three grains from *Platyopuntia*. As this sample represents a sealed context, the prickly pear pollen confirms the presence and probable use of this economic plant by the ancient site inhabitants. Interestingly, this sample also contains a relatively large quantity of Cheno-Am pollen, suggesting that a member of this group may also have been used at the site.

A single pollen wash from a mano was also examined (sample 59). Although concentration values could not be calculated, as a known volume of sediment was not used, the general condition of the grains was consistent with other samples from this site. The assemblage did not contain pollen from any cultivated or wild economic plant foods, and the assemblage was unremarkable. There was a slightly elevated amount of grass pollen (9

percent) in this sample, and it is possible that the mano was used at some time for grinding grass.

### LA 115260

Site LA 115260 is a Doña Ana-phase occupation site, located in the south-central Tularosa Valley. Vegetation currently found in the vicinity of the site includes grasses (dropseed and gramma grasses), yucca, saltbush and mesquite. A total of four pollen samples was collected at site LA 115260, representing two different levels from a sheet midden deposit (Feature 1): fill from Feature 7, an irregular oval pit and fill from Feature 1A, an oval pit. Pollen preservation in these samples was fair, with concentration values of 1,059–3,830 fossil grains/ml of sediment. Pollen counts and percentages are presented in Table 25.5.

As a whole, the assemblages from LA 115260 were dominated by pollen grains from *Artemisia*, low spine Asteraceae, Cheno-Ams, Poaceae, and *Juniperus* grains. These taxa tend to be over-represented in southwestern pollen samples due to their durability and abundance. Other taxa noted in the samples include *Cirsium*, Liguliflorae, *Ephedra*, Fabaceae, Lamiaceae, Liliaceae, Polygonaceae, Rosaceae, *Dalea*, *Pinus*, *Quercus*, and *Salix*.

Potential economic pollen types were also noted in the samples, including high spine Asteraceae, Brassicaceae, *Eriogonum*, and *Rhus*. High spine Asteraceae grains were noted in all of the samples, in percentages as high as 4.5 percent. This pollen type is normally scarce in the pollen record and it is possible that sunflowers were cultivated or encouraged in the site vicinity. Brassicaceae pollen was also noted in all samples, though only in low numbers. While members of this family may have been utilized at the site, the low frequency of Brassicaceae grains argues for a natural occurrence in the pollen samples. *Eriogonum*, noted in all samples, occurs in frequencies as high as 3 percent. This plant has a number of uses documented ethnographically, and the number of grains noted in the samples may indicate an economic usage at this site. Interestingly, Poaceae pollen is fairly high in three of the LA 115260 sediment samples, with percentages as high as 13 percent. Since a number of wild grasses were used as food and for basketry and matting, an economic use may be indicated. However, it is possible that in the past, grasses were particularly well represented in the vicinity of this site. A single grain from *Rhus* was noted in the sample from Feature1A, fill from a borrow pit. While *Rhus* was an important economic plant, the occurrence of a single grain does not necessarily indicate an economic use.

Sample 51, representing Level 3 midden fill, contains two introduced *Tamarix* grains indicating that either some contamination occurred at the time of sample collection, or that mixing of modern and ancient sediment samples has occurred. This sample also contained five *Prosopis* grains. The presence of these fragile grains supports the idea that modern materials may be mixed with the ancient sediments.

### LA 115262

Site LA 115262 is a Late Archaic and Mesilla-phase site located at the southern end of the Tularosa Valley. Vegetation currently found in the vicinity of the site includes mesquite, saltbush, creosote bush, snakeweed, grasses, yucca, and prickly pears.

A single pollen sample was collected at this site, representing fill from Feature 35, a circular basin thermal feature. Preservation was poor, with a concentration value of 1,818 grains/ml of sediment. The pollen counts and percentages are presented in Table 25.6.

The sample was dominated by low spine Asteraceae and Cheno-Am grains, with lesser amounts of *Artemisia*, high spine Asteraceae, *Boerhaavia* and *Mirabilis*-type Nyctaginaceae, Brassicaceae, Liliaceae, Poaceae, *Juniperus*, *Pinus*, and *Quercus*. Pollen types representing an economic use are wholly lacking, and taxa noted in the assemblage are species likely to be found as



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**Table 25.5 Pollen Counts and Percentages from Site LA 115260**

| | Sample | | | |
|---|---|---|---|---|
| **Taxa** | **50** | **51** | **52** | **53** |
| Apiaceae | | | | |
| *Artemisia* | 8 (4.0) | 17 8.5) | 13 (6.5) | 10 (5.0) |
| High Spine Asteraceae | 1 (0.5) | 4 (2.0) | 5 (2.5) | 9 (4.5) |
| Low Spine Asteraceae | 39 (19.5) | 54 (27.0) | 40 (20.0) | 45 (22.5) |
| *Cirsium* | | | | 1 (0.5) |
| Liguliflorae | 1 (0.5) | 2 (1.0) | 1 (0.5) | |
| *Boerhaavia*-type | | | | |
| Brassicaceae | 1 (0.5) | 2 (1.0) | 1 (0.5) | 2 (1.0) |
| Cheno-Am | 90 (45.0) | 80 (40.0) | 91 (45.5) | 82 (41.0) |
| *Cylindropuntia* | | | | |
| *Echinocereus* | | | | |
| *Ephedra nevadensis* | | | 1 (0.5) | |
| *Ephedra torreyana* | | | | |
| *Eriogonum* | 6 (3.0) | 1 (0.5) | 4 (2.0) | 4 (2.0) |
| Fabaceae | 1 (0.5) | 3 (1.5) | | 1 (0.5) |
| Gentianaceae | | | | |
| Lamiaceae | | | | 1 (0.5) |
| Liliaceae | 1 (0.5) | 1 (0.5) | 1 (0.5) | |
| *Mirabilis*-type | | | | |
| *Platyopuntia* | | | | |
| Poaceae | 26 (13.0) | 3 (1.5) | 18 (9.0) | 17 (8.5) |
| Polemoniaceae | | | | |
| Polygonaceae | | 2 (1.0) | | 2 (1.0) |
| *Portulaca* | | | | |
| Rosaceae | | 1 (0.5) | | |
| Sphaeralcea | | | | |
| *Typha* | | | | |
| *Vitis* | | | | |
| *Yucca* | | | | |
| *Zea mays* | | | | |
| *Acacia* | | | | |
| *Alnus* | | | | |
| *Carya* | | | | |
| *Dalea* | | | 1 (0.5) | |
| *Juniperus* | 15 (7.5) | 9 (3.5) | 11 (5.5) | 12 (6.0) |
| *Pinus edulis*-type | 2 (1.0) | 5 (2.5) | 5 (2.5) | 4 (2.0) |
| *Pinus ponderosa*-type | | | 2 (1.0) | |
| *Prosopis* | | 5 (2.5) | | |
| *Prunus* | | | | |
| *Quercus* | 2 (1.0) | 1 (0.5) | | 2 (1.0) |
| *Rhus* | | | | 1 (0.5) |
| *Salix* | 1 (0.5) | 1 (0.5) | | 1 (0.5) |
| *Tamarix* | | 2 (1.0) | | |
| Indeterminate | 6 (3.0) | 7 (3.5) | 6 (3.0) | 6 (3.0) |
| **Total** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** |
| Concentration Value (Grains/ml) | 1268 | 1059 | 3830 | 1636 |



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**Table 25.6 Pollen Counts and Percentages from Site LA 115262**

| | Sample |
|---|---|
| **Taxa** | **54** |
| Apiaceae | |
| *Artemisia* | 5 (2.5) |
| High Spine Asteraceae | 1 (0.5) |
| Low Spine Asteraceae | 33 (16.5) |
| *Cirsium* | |
| Liguliflorae | |
| *Boerhaavia*-type | 3 (1.5) |
| Brassicaceae | 1 (0.5) |
| Cheno-Am | 139 (69.5) |
| *Cylindropuntia* | |
| *Echinocereus* | |
| *Ephedra nevadensis* | |
| *Ephedra torreyana* | |
| *Eriogonum* | |
| Fabaceae | |
| Gentianaceae | |
| Lamiaceae | |
| Liliaceae | 1 (0.5) |
| *Mirabilis*-type | 1 (0.5) |
| *Platyopuntia* | |
| Poaceae | 3 (1.5) |
| Polemoniaceae | |
| Polygonaceae | |
| *Portulaca* | |
| Rosaceae | |
| Sphaeralcea | |
| *Typha* | |
| *Vitis* | |
| *Yucca* | |
| *Zea mays* | |
| *Acacia* | |
| *Alnus* | |
| *Carya* | |
| *Dalea* | |
| *Juniperus* | 3 (1.5) |
| *Pinus edulis*-type | 7 (3.5) |
| *Pinus ponderosa*-type | 1 (0.5) |
| *Prosopis* | |
| *Prunus* | |
| *Quercus* | 1 (0.5) |
| *Rhus* | |
| *Salix* | |
| *Tamarix* | |
| Indeterminate | 1 (0.5) |
| **Total** | **200 (100)** |
| Concentration Value (Grains/ml) | 1818 |

background taxa throughout the southwestern region. Of note, however, is the extremely high percentage of Cheno-Am pollen recovered in the sample (69.5 percent). Cheno-Ams are often over-represented in pollen samples from this region, as this pollen is produced in abundance, is durable, and is readily recognized even when highly degraded. The percentage of Cheno-Am pollen encountered in the LA 115262 is very high, however, and may signal the prehistoric use of this important plant. Fruits and seeds of both *Chenopodium* and *Amaranthus* were widely consumed by native populations throughout North America (Moerman 1998), and pollen would be expected to enter the site area through the collection of these seeds.

## LA 126181

Site LA 126181 is a site dating from the Mesilla and Doña Ana phases, located on an alluvial fan of the Jarilla Mountains, north of the town of Orogrande, New Mexico. Vegetation currently found in the site area includes creosote bush, snakeweed, sand sage, yucca, sumac, and prickly pear.

Two pollen samples from LA 126181 were selected for analysis, representing fill from Features 4 and 7, both circular basin thermal features. Concentration values were 3,428 and 5,143 grains/ml, values considered to be acceptable for analysis. Fossil pollen preservation was fairly good, and pollen counts and percentages are presented in Table 25.7.

The samples were dominated by *Artemisia*, low spine Asteraceae, Cheno-Ams, Poaceae, *Juniperus*, and *Pinus* grains. Other background taxa noted in the assemblages include high spine Asteraceae, *Cirsium*, Liguliflorae, *Boerhaavia*, *Ephedra*, Fabaceae, Liliaceae, *Sphaeralcea*, *Quercus*, and *Salix*.

Taxa encountered in the samples that may represent the prehistoric use of economic plants include Brassicaceae, *Platyopuntia*, and *Prunus* grains. Brassicaceae grains were noted in both

**Table 25.7 Pollen Counts and Percentages from LA 126181**

| | Sample | |
|---|---|---|
| **Taxa** | **55** | **56** |
| Apiaceae | | |
| *Artemisia* | 10 (5.0) | 11 (5.5) |
| High Spine Asteraceae | 1 (0.5) | |
| Low Spine Asteraceae | 85 (42.5) | 87 (43.5) |
| *Cirsium* | | 1 (0.5) |
| Liguliflorae | | 1 (0.5) |
| *Boerhaavia*-type | 1 (0.5) | |
| Brassicaceae | 7 (3.5) | 2 (1.0) |
| *Cheno-Am* | 48 (24.0) | 51 (25.5) |
| *Cylindropuntia* | | |
| *Echinocereus* | | |
| *Ephedra nevadensis* | 1 (0.5) | 4 (2.0) |
| *Ephedra torreyana* | | 1 (0.5) |
| *Eriogonum* | | |
| Fabaceae | 1 (0.5) | |
| Gentianaceae | | |
| Lamiaceae | | |
| Liliaceae | 1 (0.5) | |
| *Mirabilis*-type | | |
| *Platyopuntia* | 1 (0.5) | |
| Poaceae | 14 (7.0) | 18 (9.0) |
| Polemoniaceae | | |
| Polygonaceae | | |
| *Portulaca* | | |
| Rosaceae | | |
| Sphaeralcea | | 1 (0.5) |
| *Typha* | | |
| *Vitis* | | |
| *Yucca* | | |
| *Zea mays* | | |
| *Acacia* | | |
| *Alnus* | | |
| *Carya* | | |
| *Dalea* | | |
| *Juniperus* | 10 (5.0) | 13 (6.5) |
| *Pinus edulis*-type | 13 (6.5) | 4 (2.0) |
| *Pinus ponderosa*-type | 1 (0.5) | |
| *Prosopis* | | |
| *Prunus* | 1 (0.5) | |
| *Quercus* | | 1 (0.5) |
| *Rhus* | | |
| *Salix* | 1 (0.5) | |
| *Tamarix* | | |
| Indeterminate | 4 (2.0) | 5 (2.5) |
| **Total** | **200 (100)** | **200 (100)** |
| Concentration Value (Grains/ml) | 3428 | 5143 |

samples from this site, with values as high as 3.5 percent. The presence of such a high percentage of normally rare pollen may indicate an economic usage. Both *Lepidium* (peppergrass) and *Descurainea* (tansy mustard) are in this family, and the pollen in these samples may represent the ancient use of these or another plant. A single *Platyopuntia* grain was identified in the Feature 4 sample. As *Platyopuntia* pollen is large and heavy, it rarely travels any distance from the plant. Thus its occurrence in feature fill at this site may indicate the prehistoric use of this important plant. A single *Prunus* pollen grain was also noted in the Feature 4 sample. *Prunus* trees favor a more mesic environment, such as a montane or riverine setting, environments quite different from that of the project area. *Prunus* pollen grains rarely travel far from their source, and the presence of this diagnostic grain may signal the deliberate collection of fruits of this important plant by the site's prehistoric inhabitants.

## Orogrande 1 (LA 128699)

Site LA 128699 is a large, prehistoric residential site, located at the base of the Jarilla Mountains, near the town of Orogrande, New Mexico. It contains an extensive Late Archaic, Fresnal phase component (ca. 2500–900 B.C.), and a smaller and more spatially restricted, Mesilla-phase component. Vegetation recorded in the site vicinity represents typical Chihuahuan Desert flora including mesquite, saltbush, snakeweed, yucca, and various grasses and weeds.

A total of 14 pollen samples from site LA 128699 was examined, representing a variety of features, including circular, oval, and sub-rectangular thermal features (Features 3, 25, 20, 26, 81, 79, 38, 70, 78, 102, and 104); a roasting pit (Feature 33); a sub-rectangular, Mesilla-phase pithouse feature (Feature 23); and fill from Feature 43, a Fresnal-phase, shallow, pithouse basin. Pollen preservation at the site was generally quite poor, with concentration values of 540–15,882 fossil grains/ml of sediment. Seven samples (2–4, 10–12, and 14) contained so little pollen that counts could not



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be made. It appears that sediments at this site have been oxidized to a greater degree than any other site in the project area. This is perhaps due in part to the relatively greater antiquity of the archaeological deposits here. Because of differential preservation demonstrated by the low concentration values, interpretations must be made with caution. Pollen counts are presented in Table 25.8.

The pollen assemblages from site LA 128699 were dominated by durable pollen types including *Artemisia*, low spine Asteraceae, Cheno-Ams, Poaceae, and *Juniperus*. These are among the taxa typically over-represented in Southwestern sediments with poor pollen preservation. Other taxa noted in the samples include high spine Asteraceae, *Cirsium*, Liguliflorae, *Boerhaavia, Ephedra*, Fabaceae, Gentianaceae, Lamiaceae, Liliaceae, Polygonaceae, Sphaeralcea, *Acacia, Pinus*, *Quercus, and Salix.* These taxa represent background-type pollen grains normally encountered in sediment samples from the southwestern United States.

A number of taxa were noted in the samples that may represent economic species, including Brassicaceae, *Eriogonum*, *Vitis*, *Prunus*, and *Rhus*. Brassicaceae pollen grains were noted in five samples, with frequencies ranging 1.0–3 percent. Although these values are not exceedingly high, they suggest that a member of the mustard family may have been used as a food item at the site. Both *Lepidium* and *Descurainia* have documented economic uses (Moerman 1998), and one of these plants may be the source of this pollen. *Eriogonum* was also noted in five samples, but only a single grain was identified in each of these samples. The low incidence of this taxon does not argue for the intentional use of this plant in antiquity.

A single *Vitis* pollen grain was noted in sample 1, fill from Feature 3, a basin thermal feature. Although this sample contained a large quantity of well preserved pollen, the presence of modern *Carya* (pecan) and well-preserved *Prosopis* (mesquite) argues that many or most of the grains in this sample are actually intrusive and modern. This is the only sample at the site to contain pollen from *Acacia*, a type that is normally fragile and found only in perfectly preserved assemblages.

Interestingly, two of the pollen samples (7 and 8) contained relatively high percentages of grass pollen. A number of grasses have important economic uses in the region, for both food and matting, and increases in pollen from this plant may indicate the past use of these materials. In sample 6, there is a relatively high percentage (3.5 percent) of high spine Asteraceae (sunflower type) pollen. This type is normally rare in pollen samples, and its occurrence in the sample may signal its use by the ancient site inhabitants.

It is noteworthy that *Prunus* pollen was identified in three samples (6, 7 and 9), all from thermal features. *Prunus* is not found in the site area today and is generally restricted to montane or riparian settings. Pollen from *Prunus* is insect-pollinated and rarely travels far from the tree; thus the presence of this grain in the site sediments argues for its use in antiquity. While peaches (*Prunus persica*) are grown in the general region, the fact that other modern contaminant grains are lacking in these samples argues against these grains being modern contaminants.

*Rhus*, or sumac, grains were noted in two samples from site LA 128699, both from thermal features. *Rhus* is an important economic plant and has been used for food, medicine, and dye. The presence of pollen from *Rhus*, even in low frequencies, may indicate that this plant was used at the site in the past.

### Orogrande 2 (LA 128700)

Site LA 128700 is a Jornada Mogollon residential and campsite, located in the south central portion of the Tularosa Valley, near the town of Orogrande, New Mexico. The site includes both Late Archaic and Doña Ana-phase components. Modern vegetation in the site vicinity includes



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**Table 25.8 Pollen Counts and Percentages from LA 128699**

| | Sample | | | | | | |
|---|---|---|---|---|---|---|---|
| **Taxa** | **1** | **5** | **6** | **7** | **8** | **9** | **13** |
| Apiaceae | | | | | | | |
| *Artemisia* | 2 (1.0) | 16 (8.0) | 32 (16.0) | 26 (13.0) | 16 (8.0) | 27 (13.5) | 41 (20.5) |
| High Spine Asteraceae | 2 (1.0) | 3 (1.5) | 7 (3.5) | 2 (1.0) | 1 (0.5) | 3 (1.5) | 2(1.0) |
| Low Spine Asteraceae | 92 (46.0) | 34 (17.0) | 52 (26.0) | 60 (30.0) | 68 (34.0) | 51 (25.5) | 56 (28.0) |
| *Cirsium* | | | 4 (2.0) | 1 (0.5) | | | 1 (0.5) |
| Liguliflorae | | 1 (0.5) | 1 (0.5) | 1 (0.5) | 1 (0.5) | | 1 (0.5) |
| *Boerhaavia*-type | | 1 (0.5) | | 1 (0.5) | | 2 (1.0) | |
| Brassicaceae | 2 (1.0) | 3 (1.5) | | 3 (1.5) | 6 (3.0) | 5 (2.5) | |
| Cheno-Am | 26 (13.0) | 76 (38.0) | 45 (22.5) | 31 (15.5) | 34 (17.0) | 60 (30.0) | 34 (17.0) |
| *Cylindropuntia* | | | | | | | |
| *Echinocereus* | | | | | | | |
| *Ephedra nevadensis* | 1 (0.5) | 5 (2.5) | | 4 (2.0) | 2 (1.0) | 4 (2.0) | 1 (0.5) |
| *Ephedra torreyana* | | 2 (1.0) | | | 2 (1.0) | | |
| *Eriogonum* | | 1 (0.5) | 1 (0.5) | 1 (0.5) | 1 (0.5) | | 1 (0.5) |
| Fabaceae | 1 (0.5) | | 1 (0.5) | 1 (0.5) | | | 1 (0.5) |
| Gentianaceae | | | | 1 (0.5) | | 1 (0.5) | |
| Lamiaceae | | | 1 (0.5) | | 1 (0.5) | | |
| Liliaceae | | | | | | | 2 (1.0) |
| *Mirabilis*-type | | | | | | | |
| *Platyopuntia* | | | | | | | |
| Poaceae | 13 (6.5) | 19 (9.5) | 14 (7.0) | 26 (13.0) | 23 (11.5) | 14 (7.0) | 11 (5.5) |
| Polemoniaceae | | | | | | | |
| Polygonaceae | 1 (0.5) | | | | 1 (0.5) | 2 (1.0) | 1 (0.5) |
| *Portulaca* | | | | | | | |
| Rosaceae | | | | | | | |
| *Sphaeralcea* | | | 1 (0.5) | 1 (0.5) | 1 (0.5) | | |
| *Typha* | | | | | | | |
| *Vitis* | 1 (0.5) | | | | | | |
| *Yucca* | | | | | | | |
| *Zea mays* | | | | | | | |
| *Acacia* | 1 (0.5) | | | | | | |
| *Alnus* | | | | | | | |
| *Carya* | 3 (1.5) | | | | | | |
| *Dalea* | | | | | | | |
| *Juniperus* | 17 (8.5) | 19 (9.5) | 18 (9.0) | 19 (9.5) | 22 (11.0) | 7 (3.5) | 23 (11.5) |
| *Pinus edulis*-type | 14 (7.0) | 4 (2.0) | 4 (2.0) | 4 (2.0) | 3 (1.5) | 5 (2.5) | 1 (0.5) |
| *Pinus ponderosa*-type | 1 (0.5) | | | | | | |
| *Prosopis* | 9 (4.5) | 1 (0.5) | | | | | |
| *Prunus* | | | 1 (0.5) | 1 (0.5) | | 2 (1.0) | |
| *Quercus* | 9 (4.5) | 6 (3.0) | 5 (2.5) | 4 (2.0) | 5 (2.5) | 6 (3.0) | 7 (3.5) |
| *Rhus* | | 1 (0.5) | | 1 (0.5) | | | |
| *Salix* | | | | | 1 (0.5) | 1 (0.5) | 1 (0.5) |
| *Tamarix* | | | | | | | |
| Indeterminate | 5 (2.5) | 8 (4.0) | 13 (6.5) | 12 (6.0) | 12 (6.0) | 10 (5.0) | 16 (8.0) |
| **Total** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** |
| Concentration Value (Grains/ml) | 15882 | 658 | 802 | 648 | 703 | 1021 | 540 |



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mesquite, creosote bush, tarbush, saltbush, snakeweed, yucca, and various grasses and unidentified weeds.

A total of five pollen samples was collected from this site, including Features 33, 35, and 38, all oval basin thermal features; Feature 43, a circular basin thermal feature; and Feature 29, a roasting pit. Fossil pollen concentration values were generally low, ranging 1,250–3,913 grains/ml of sediment. All samples from this site were done using 200-grain pollen counts (see Table 25.9). The pollen assemblages from LA 128700 are dominated by low spine Asteraceae, Cheno-Am, Poaceae, and *Juniperus* grains, with significant amounts of *Artemisia*, *Ephedra*, and *Pinus* grains. These taxa all tend to be over-represented in southwestern sediments, particularly when the sediments have been oxidized. Other taxa noted in the samples include high spine Asteraceae, *Cirsium*, *Boerhaavia* and *Mirabilis*-type Nyctaginaceae, Fabaceae, Liliaceae, Polygonaceae, *Sphaeralcea*, *Quercus*, and *Salix*.

Potential economic taxa noted in the samples include low numbers of Brassicaceae grains in four samples, single grain occurrences of *Eriogonum* in three samples, and single grains of *Platyopuntia* in two samples. While both *Eriogonum* and Brassicaceae are widespread, and their pollen could represent natural occurrences in the sediments, they both have documented economic uses as food and medicine. The low numbers of these grains does not argue for an economic use, however. *Platyopuntia*, a large and heavy grain, was noted in two samples. Because of the grain's size, it is unlikely that pollen from this plant was accidentally introduced into the site features (Features 33 and 43). Thus these grains indicate that prickly pear may have been roasted or prepared in these features.

A single *Carya* pollen grain was noted in sample 15, representing fill from Feature 33. This pollen grain is likely to be a modern intrusive grain or a contaminate.

## Orogrande North (LA 128708)

Site LA 128708 is a prehistoric residential site, with an associated industrial component. The prehistoric remains include Late Archaic and Mesilla-phase components. Vegetation in the site vicinity includes mesquite, creosote bush, saltbush, tarbush, snakeweed, yucca, allthorn, prickly pear cactus, and various grasses and unidentified weeds.

Five pollen samples were collected from site LA 128708, and represent Features 2 and 39, both roasting pits; Features 41 and 45, both oval basin thermal features; and Feature 42, a circular basin thermal feature. Pollen preservation was generally poor, with concentration values of 513–2,389 grains/ml of sediment, values considered to be extremely low. Sample 20, from Feature 2, did not contain enough pollen to provide a 200-grain count. Despite these low values, counts are useful in providing a listing of plants likely to have been present in the site area. Pollen counts and percentages are presented in Table 25.10.

All of the LA 128708 samples were dominated by pollen from *Artemisia*, low spine Asteraceae, Cheno-Ams, Poaceae, *Juniperus*, and *Pinus*. Other taxa noted in the samples include high spine Asteraceae, *Cirsium*, Liguliflorae, *Ephedra*, Fabaceae, Lamiaceae, Liliaceae, *Mirabilis*-type, Polygonaceae, *Sphaeralcea*, and *Quercus*.

Several potential economic plants were noted in the samples as well, including Brassicaceae, *Echinocereus*, *Eriogonum*, *Platyopuntia*, *Portulaca*, and *Prunus*. Brassicaceae pollen was represented by single grains in three samples and *Eriogonum* in two samples. While these plants may have been employed at this site, the rarity of the grains argues against their economic use. *Echinocereus* is a rare grain in southwestern pollen assemblages; its presence in Feature 45, an oval basin thermal feature, may indicate that this plant was consumed at the site in the past. Likewise a single grain of *Platyopuntia* was noted in Feature 39, a roasting pit. Both *Platyopuntia*



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**Table 25.9 Pollen Counts and Percentages from LA 128700**

| | Sample | | | | |
|---|---|---|---|---|---|
| **Taxa** | **15** | **16** | **17** | **18** | **19** |
| Apiaceae | | | | | |
| *Artemisia* | 10 (5.0) | 4 (2.0) | 10 (5.0) | 13 (6.5) | 6 (3.0) |
| High Spine Asteraceae | 1 (0.5) | 6 (3.0) | | 2 (1.0) | |
| Low Spine Asteraceae | 60 (30.0) | 21 (10.5) | 77 (38.5) | 48 (24.0) | 79 (39.5) |
| *Cirsium* | | 1 (0.5) | | 2 (1.0) | |
| Liguliflorae | | | | | |
| *Boerhaavia*-type | | | 4 (2.0) | | 3 (1.5) |
| Brassicaceae | 2 (1.0) | 1 (0.5) | | 2 (1.0) | 1 (0.5) |
| Cheno-Am | 70 (35.0) | 132 (66.0) | 63 (31.5) | 75 (37.5) | 53 (26.5) |
| *Cylindropuntia* | | | | | |
| *Echinocereus* | | | | | |
| *Ephedra nevadensis* | 10 (5.0) | 3 (1.5) | 10 (5.0) | 17 (8.5) | 7 (3.5) |
| *Ephedra torreyana* | | | | | 1 (0.5) |
| *Eriogonum* | 1 (0.5) | | 1 (0.5) | 1 (0.5) | |
| Fabaceae | | | | | 2 (1.0) |
| Gentianaceae | | | | | |
| Lamiaceae | | | | | |
| Liliaceae | 1 (0.5) | | | | |
| *Mirabilis*-type | | | 1 (0.5) | 1 (0.5) | |
| *Platyopuntia* | 1 (0.5) | | | | 1 (0.5) |
| Poaceae | 9 (4.5) | 10 (5.0) | 14 (7.0) | 9 (4.5) | 17 (8.5) |
| Polemoniaceae | | | | | |
| Polygonaceae | 1 (0.5) | | | | 1 (0.5) |
| *Portulaca* | | | | | |
| Rosaceae | | | | | |
| *Sphaeralcea* | | | | | 1 (0.5) |
| *Typha* | | | | | |
| *Vitis* | | | | | |
| *Yucca* | | | | | |
| *Zea mays* | | | | | |
| *Acacia* | | | | | |
| *Alnus* | | | | | |
| *Carya* | 1 (0.5) | | | | |
| *Dalea* | | | | | |
| *Juniperus* | 12 (6.0) | 7 (3.5) | 7 (3.5) | 9 (4.5) | 13 (6.5) |
| *Pinus edulis*-type | 7 (3.5) | 7 (3.5) | 6 (3.0) | 16 (8.0) | 7 (3.5) |
| *Pinus ponderosa*-type | | 1 (0.5) | | 2 (1.0) | |
| *Prosopis* | | | | | |
| *Prunus* | | | | | |
| *Quercus* | 6 (3.0) | 2 (1.0) | 2 (1.0) | 1 (0.5) | 2 (1.0) |
| *Rhus* | | | | | |
| *Salix* | 1 (0.5) | | | 1 (0.5) | |
| *Tamarix* | | | | | |
| Indeterminate | 7 (3.5) | 5 (2.5) | 5 (2.5) | 1 (0.5) | 6 (3.0) |
| **Total** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** |
| Concentration Value (Grains/ml) | 3913 | 2038 | 1250 | 3103 | 1818 |



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**Table 25.10 Pollen Counts and Percentages from Site LA 128708**

| | Sample | | | |
|---|---|---|---|---|
| **Taxa** | **21** | **22** | **23** | **24** |
| Apiaceae | | | | |
| *Artemisia* | 12 (6.0) | 9 (4.5) | 18 (9.0) | 12 (6.0) |
| High Spine Asteraceae | 3 (1.5) | 1 (0.5) | 1 (0.5) | |
| Low Spine Asteraceae | 46 (23.0) | 31 (15.5) | 47 (23.5) | 21 (10.5) |
| *Cirsium* | 1 (0.5) | | 2 (1.0) | 2 (1.0) |
| Liguliflorae | 2 (1.0) | | | |
| *Boerhaavia*-type | | | | |
| Brassicaceae | 1 (0.5) | | 1 (0.5) | 1 (0.5) |
| Cheno-Am | 81 (40.5) | 103 (51.5) | 91 (45.5) | 116 (58.0) |
| *Cylindropuntia* | | | | |
| *Echinocereus* | | | | 1 (0.5) |
| *Ephedra nevadensis* | | 2 (1.0) | 4 (2.0) | 7 (3.5) |
| *Ephedra torreyana* | | | | |
| *Eriogonum* | 1 (0.5) | | | 1 (0.5) |
| Fabaceae | 1 (0.5) | | | |
| Gentianaceae | | | | |
| Lamiaceae | | | | 1 (0.5) |
| Liliaceae | | | 1 (0.5) | |
| *Mirabilis*-type | | | | 1 (0.5) |
| *Platyopuntia* | 1 (0.5) | | | |
| Poaceae | 11 (5.5) | 20 (10.0) | 8 (4.0) | 9 (4.5) |
| Polemoniaceae | | | | |
| Polygonaceae | 1 (0.5) | | | |
| *Portulaca* | | 1 (0.5) | | |
| Rosaceae | | | | |
| Sphaeralcea | | | | 1 (0.5) |
| *Typha* | | | | |
| *Vitis* | | | | |
| *Yucca* | | | | |
| *Zea mays* | | | | |
| *Acacia* | | | | |
| *Alnus* | | | | |
| *Carya* | | | | |
| *Dalea* | | | | |
| *Juniperus* | 15 (7.5) | 15 (7.5) | 13 (6.5) | 12 (6.0) |
| *Pinus edulis*-type | 8 (4.0) | 7 (3.5) | 1 (0.5) | 5 (2.5) |
| *Pinus ponderosa*-type | | | | 1 (0.5) |
| *Prosopis* | | | | |
| *Prunus* | | | 1 (0.5) | |
| *Quercus* | 7 (3.5) | 4 (2.0) | 4 (2.0) | 4 (2.0) |
| *Rhus* | | | | |
| *Salix* | | | | |
| *Tamarix* | | | | |
| Indeterminate | 9 (4.5) | 7 (3.5) | 8 (4.0) | 5 (2.5) |
| **Total** | **200 (100)** | **200 (100)** | **200 (100)** | **200 (100)** |
| Concentration Value (Grains/ml) | 513 | 813 | 1371 | 2389 |



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and *Echinocereus* fruits are edible and some pollen might be expected to remain on the fruits after the flowers have dropped off. As these pollen types generally stay close to the plant, and wild specimens of these plants would not be expected to be present growing in the midst of a site, it seems likely that these grains may have been brought into the site area through past human activity.

A single *Portulaca* pollen grain was identified in sample 22, from Feature 41, an oval basin thermal feature. This diagnostic grain is large and fairly heavy and generally rare in pollen records. Its presence is possibly due to past human activity as the plant was used as a food in antiquity. More problematic, however, is the appearance of a single *Prunus* grain in sample 23, from Feature 42, a circular basin thermal feature. *Prunus* is not native to the site area, although it can be found in nearby montane environments in both Texas and New Mexico (Correll and Johnston 1979; Elias 1980). As *Prunus* grains rarely travel any distance from the plants, the appearance of pollen from this taxon may indicate that *Prunus* fruit, with adhering pollen, was brought into the site area from some distance.

## Summary

A total of 59 pollen samples was examined as part of the US 54 project in southern New Mexico. These samples represent feature fill from seven archaeological sites. In addition, a modern surface sediment sample and a single pollen wash from a mano were also examined. It was anticipated that a detailed analysis of preserved fossil pollen might provide insights into past economic plant use and other aspects of life of the prehistoric site inhabitants.

Pollen was preserved in 51 of the 59 samples, and 200-grain counts were made for each sample. Based largely on the low concentration values, it is clear that most of the sediments have suffered from some degree of oxidization, and in many cases, it is suspected than the more fragile grains have been differentially lost. The percentages from several taxa, including *Artemisia*, low spine Asteraceae, Cheno-Ams, Poaceae, and *Juniperus* have apparently been artificially increased by this oxidation process. These taxa are all produced in large numbers, are relatively durable, and are readily recognizable even when degraded. Thus, these taxa typically remain in assemblages even when more fragile grains have been lost. Interpretations based on differentially preserved assemblages, then, must be made with extreme caution.

Most of the samples examined for this study were from some form of thermal feature, including hearths and roasting pits. These features are generally not the best places to sample for pollen for a number of reasons. First, much of the pollen associated with the use of the feature is likely to be incinerated through the normal use of the feature. Thus many or most of the grains present in the feature may have infiltrated the sediments after the feature was abandoned. Also, these features tend to have significant quantities of charcoal in size ranges consistent with pollen grains. Pollen extraction techniques cannot effectively remove charcoal from ancient pollen grains in the residue. Thus, counting pollen in these samples can often be quite difficult, as one has to search for grains among the millions of charcoal fragments. Therefore, it is usually best to sample non-thermal features, although non-thermal pits were uncommon in the US 54 sites (see Chapter 30). When features of this type are not present, however, much information can still be gained from a study of this nature.

Durable taxa, typically over-represented in southwestern pollen samples, dominate most of the pollen assemblages from the US 54 sites. Possible economic types were noted in many of the samples, however, and include Brassicaceae, high spine Asteraceae, *Eriogonum*, *Echinocereus*, *Cylindropuntia* and *Platyopuntia*, *Portulaca*, *Typha*, *Vitis*, *Yucca*, *Prunus*, *Rhus*, and *Zea mays*. A number of pollen types are produced in low numbers, do not disperse from the plant readily, or are heavy. These types are particularly telling when assessing the prehistoric economic potential

of a plant, and include *Echinocereus*, *Cylindropuntia* and *Platyopuntia*, and *Portulaca*.

Pollen from domesticated *Zea mays* was noted only at the Jaca site (LA 6829), where it occurred in eight samples. In one sample (27), representing fill from an oval irregular pit, maize pollen comprised 14 percent of the pollen assemblage. Clearly, economic pollen present in such a high frequency demonstrates that this feature was associated with grain preparation or storage.

Other taxa noted in the samples represent wild plants frequently used for economic purposes, including members of the Cheno-Am group and Poaceae, and increases of pollen percentages may signal the past use of these important plants. As both of these grains tend to be over-represented in poorly preserved assemblages, however, interpretation of the prehistoric use of these plants from pollen can be difficult.

Little information on paleoenvironmental conditions in the project area can be gained from this study. As most of the recovered pollen assemblages are skewed toward more durable species, it is clear that much ancient pollen originally deposited in the sediments has been lost as a result of taphonomic processes. Still, the list of taxa identified in the archaeological samples closely approximates those grains found in the modern surface sample, and virtually all identified taxa are known to occur in the site vicinity today. It appears there has been little change in the regional paleoenvironmental conditions. Samples presumably contaminated with modern sediments do contain two introduced taxa that are not found in the archaeological sediments. Both *Carya* and *Tamarix* have been introduced into the local flora. *Carya* (pecan) is grown commercially in the area, and *Tamarix* (salt cedar) is a troublesome, invasive tree found in streambeds throughout the southwestern United States.

Although much information was gained from this study of thermal features, future studies in this area should target additional analyses of non-thermal features from well-dated sites. Here, the fossil pollen preservation potential is greater, and we are more likely to find pollen associated with the use of the features. Additional pollen washes should also be examined as economic pollen types, again, are directly associated with the use of these tools.



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Chapter 26

# Phytolith Remains

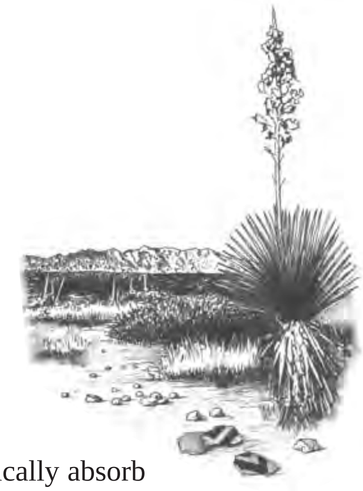
*Steven Bozarth and Jim A. Railey*

## Introduction

### *Research Goals*

The primary objective of this study was to identify and assess the presence of culturally significant phytoliths from the US 54 sites. Along with data from macrobotanical and pollen remains, the phytolith analysis results are used to address subsistence-related questions outlined in Chapter 4.

Phytolith samples were analyzed from six of the 11 data recovery sites (Table 26.1). The samples include three from Late Archaic and/or early Mesilla-phase features (LA 115256, Feature 3; LA 115263, Feature 2; and LA 126181, Feature 4) and two Doña Ana- and/or El Paso-phase sites (LA 115260 and LA 115265), and the Jaca Site, dominated by a late Doña Ana/early El Paso-phase component (LA 6829). The features sampled include thermal features, non-thermal pits, and postholes, some within structures. In addition, a control sample was collected and analyzed from a non-site context in the project area.



### *Phytolith Formation*

Growing plants typically absorb water containing dissolved silica through their roots. Microscopic silica bodies are subsequently produced by the precipitation of hydrated silicon dioxide (SiO2onH2O) within the plants' cells, cell walls, and intercellular spaces. Silica bodies that have characteristic shapes and sizes are called opal phytoliths (Wilding and Drees 1971). The term phytolith is derived from the Greek words *phyton*, meaning plant, and *lithos*, meaning stone. Opal is the common name for amorphous, hydrated silica dioxide. Opaline bodies formed in plants without specific shapes are simply plant opal.

Phytoliths form in most plants and are produced in a multitude of shapes and sizes, and many phytolith types are specific to particular groups of plants. A phytolith type is considered "characteristic" if it is common in one specific taxon, but also produced in limited amounts in one or more other taxa. A phytolith type is "diagnostic" if its shape and/or size are specific to a particular

**Table 26.1 Contextual Data for Analyzed Phytolith Samples**

| Site | Feature | Feature Type | Cultural Affiliation |
|---|---|---|---|
| LA 6829 | 38 | Non-thermal pit | Doña Ana/El Paso phase |
| LA 6829 | 41 | Thermal Feature | Doña Ana/El Paso phase |
| LA 6829 | 54.16 | Non-thermal pit, inside communal structure | Early El Paso phase |
| LA 6829 | 85 | Thermal Feature | Doña Ana/El Paso phase |
| LA 6829 | 88 | Non-thermal pit | Doña Ana/El Paso phase |
| LA 6829 | 163 | Non-thermal pit | Doña Ana/El Paso phase |
| LA 6829 | 178 | Thermal feature | Doña Ana/El Paso phase |
| LA 6829 | 185 | Thermal feature | Doña Ana/El Paso phase |
| LA 115256 | 3 | Thermal feature | Late Archaic or Early Mesilla phase |
| LA 115260 | 1 | Midden (2 samples) | Doña Ana phase |
| LA 115260 | 1a | Non-thermal pit | Doña Ana phase |
| LA 115263 | 2 | Thermal feature | Late Archaic or Early Mesilla phase |
| LA 115265 | 1 | Thermal feature | Doña Ana phase |
| LA 126181 | 4 | Thermal feature | Mesilla phase |

taxon. Fortunately, many phytoliths are resistant to weathering and are preserved in most soils for long periods of time.

### *Archaeological Phytolith Research in the American Southwest*

The most comprehensive analysis of maize phytoliths was conducted by Bozarth (1996, 1997) on Southwestern varieties of the five types of maize (flour, flint, dent, sweet, and popcorn). This study demonstrated that cobs produce at least two types of diagnostic phytoliths. Another type of diagnostic maize phytolith is a bilobate, short-cell form with notches on its sides, non-indented rounded or slightly pointed ends, and a narrow-ridged top that is perpendicular to the side notches. It is produced in various aerial parts of the plant (husks, leaves, leaf sheaths, etc.), but not the cob.

Maize cob phytoliths have been recovered in various features in pre-Classic, Hohokam sites (Bozarth 1992b, 1994) and Classic sites (Bozarth 1992a, 1992b, 1994, 1996, 1997) in Arizona. Cob phytoliths also were identified in ceramic and ground stone washes at another prehistoric Hohokam site in Arizona (Bozarth 2000). Non-cob maize phytoliths have been identified in pre-Classic sites (Bozarth 1992b, 1994, 1996) and Classic sites (Bozarth 1994) in Arizona. Virtually identical phytoliths are produced in non-hybrid, heirloom maize varieties from the Great Plains (Bozarth 1993).

Diagnostic phytoliths also are formed in the pods of Southwestern varieties of common beans (*Phaseolus vulgaris*) and tepary beans (*P. acutifolius*) (Bozarth 1996). These distinctive phytoliths, which consist of silicified hooked hairs, also are produced in common beans from the Great Plains (Bozarth 1986, 1990). Bean phytoliths were identified in isolates from pre-Classic and Classic sites in the lower Verde River Valley in central Arizona (Bozarth 1996, 1997).

Taxonomic phytolith classification has demonstrated that scalloped, spheroidal phytoliths formed in the rinds of squash (*Cucurbita argyrosperma, C. moshata,* and *C. pepo*) are diagnostic of that genus in the American Southwest (Bozarth 1996) and the Great Plains (Bozarth 1985, 1986, 1987). Additionally, there are two other types of phytoliths formed in squash fruits that are characteristic of the genus (Bozarth 1996).

Analysis of Southwestern reference species also has shown that agave produces a type of phytolith that is characteristic at the genus level. This type of phytolith has been recovered in a Classic-period field house in the lower Verde River Valley (Bozarth 1996, 1997). An agave phytolith also was identified in a ground stone wash at AZ U:10:127 (Bozarth 2000).

## Methods

### *Phytolith Classification*

Taxonomic classification of appropriate reference collections is the key to meaningful archaeological phytolith analysis. The classification of archaeological phytoliths was based on comparative analyzes of an extensive reference collection consisting of both domesticated and wild species. The domesticated phytolith collection consists of 120 samples from 26 Southwestern cultigens, including various parts of grain amaranth (*Amaranthus cruentus* and *A. hypochondriacus*), jack beans (*Canavalia ensiformis*), chile (*Capsicum annuum*), squash (*C. pepo, C. maxima, C. mochata*, and *C. mixta*), cotton (*Gossypium hirsutum var. puntatum*), sunflowers (*Helianthus annuus var. macrocarpa*), gourds (*Lagenaria siceraria*), tobacco (*Nicotiana rustica*), tomatillo (*Physalis philadelphica var. philadelphica*), tepary beans (*Phaseolus acutifolius*), common beans (*P. vulgaris*), and the five kernel types of maize (*Zea mays*).

The non-domesticated phytolith collection is based on 118 samples from 83 species native to the American Southwest, including two species of agave (*A. crysantha* and *A. murpheyi*), careless weed (*Amaranthus palmeri*), Cucurbita digitata, wild buffalo gourd (*C. foetidissima*), and wild tobacco (*Nicotiana trigonophylla*). Analysis of the domesticated and non-domesticated phytolith

collections for the Lower Verde Archaeological Project (LVAP) (Bozarth 1997) resulted in the most extensive and comprehensive phytolith classification of Southwestern cultigens and selected wild edible plant species.

Based on comparative analyses of these collections, it was determined that diagnostic phytoliths also are produced in certain wild edible plant materials native to the American Southwest, including hackberry fruits (*Celtis reticulata*) (Bozarth 1997), Christmas cholla fruits (*Opuntia leptocaulis*), and prickly pear fruits (*Opuntia phaeacantha*).

### Phytolith Aggregates

Phytolith aggregates also should be evaluated in archaeological studies. Phytolith research in the Near East indicates that the formation of silica skeletons (phytolith aggregates) may be related to the growing environment (Rosen 1991). It has been shown that this process is enhanced by irrigation, and that the presence of large phytolith aggregates can be used as evidence for ancient irrigation in the Near East (Rosen 1994). The presence of phytolith aggregates also may indicate prehistoric irrigation in other areas such as the American Southwest.

### Collection Phytolith Sediment Samples

Sediment samples were collected for phytolith analysis from six prehistoric residential sites. A total of 16 samples was processed for phytoliths, including a non-site control sample. The samples came from a variety of features (see Table 26.1). All archaeological samples were collected by TRC and SWCA staff members. All necessary provenience and chronological data were provided by TRC.

### Extraction of Phytoliths from Sediment Samples

Phytoliths were extracted from 5-gram sediment samples. This procedure consists of seven basic steps: 1) removal of carbonates with dilute hydrochloric acid; 2) removal of colloidal organics, clays, and fine silts by deflocculation with sodium pyrophosphate, centrifugation, and decantation through a 7-um filter; 3) oxidation of sample to remove organics; 4) introduction of “spike” spores; 5) heavy-liquid flotation of phytoliths from the heavier clastic mineral fraction using zinc bromide concentrated to a specific gravity of 2.3; 6) washing and dehydration of isolate with butanol; and 7) dry storage in a 1-dram glass vial. The “spike” tablets containing *Lycopodium* (clubmoss) spores were introduced into the soil/sediment sample prior to the flotation in order to verify phytolith extractions and for quantitative evaluation of microfossil concentrations (see following section). After thorough mixing, part of the isolate was mounted on a microscope slide in non-drying immersion oil for microscopy under a 22 x 40-mm cover glass and sealed with clear nail lacquer.

### Phytolith Concentrations

As mentioned above, “spike” tablets containing 12,489 ± 491 *Lycopodium* (clubmoss) spores per tablet were introduced into the soil/sediment sample prior to the flotation in order to verify phytolith extractions and for quantitative evaluation of microfossil concentrations. *Lycopodium* was selected for the following reasons: (1) it is exotic to the study area; (2) its spores are distinctive and easy to identify; (3) it is commonly used to calculate pollen and phytolith concentrations; and (4) it is readily available. Phytolith concentrations per gram were estimated by multiplying the number of fossil phytoliths counted by the number of *Lycopodium* spores added, divided by the number of Lycopodium spores counted, which is then divided by five, the weight of the samples in grams. This calculation is the same as that reported by Pearsall (1989) except that the number of microfossils per sample is divided by the sample weight to give the number of microfossils per gram.

### Analysis of Phytolith Isolates

The phytolith isolates were scanned for cultigens and wild edible plants. Due to the considerable



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variations in concentration among the various phytolith isolates, it was decided that instead of scanning a fixed sum, a minimum of two percent of each phytolith isolate, would be scanned to provide comparable results.

## Results and Interpretation of Phytolith Data

The phytolith data are presented in Table 26.2. Results of phytolith analysis were mixed. Samples from LA 115256, LA 115260, LA 115265, and LA 126181 yielded high concentrations of phytoliths (with the exception of one sample from LA 115260). Concentrations varied widely, from low to extremely high, in samples from the Jaca site (LA 6829). The one sample from LA 115263 produced a rather low concentration.

Culturally significant phytoliths were identified in only three samples: one each from Jaca (LA 6829), LA 115260, and LA 115265. All three of these samples yielded maize cob phytoliths, and the sample from Jaca also yielded a single phytolith from a domestic bean. These three sites all contain Doña Ana phase remains, with the occupation at Jaca (LA 6829) extending into the early El Paso phase. These are also the only three sites to yield macrobotanical remains of cultigens and culturally important seeds from flotation samples (see Chapter 24). Jaca was the only site to yield maize pollen (see Chapter 25).

The presence of maize cob phytoliths at Jaca, LA 115260, and LA 115265 underscores the use of, and dependence upon, maize by Doña Ana times. Moreover, the presence of maize macrobotanical remains, pollen, and phytoliths at Jaca (the only site to produce maize from all three classes of archaeobotanical remains), indicates that maize was not only consumed at the site, but was probably grown and processed there as well. That the inhabitants of Jaca also used domesticated beans is evidenced by both phytolith and macrobotanical remains.

In contrast, the absence of phytoliths from cultigens and economically significant species in the phytolith samples from LA 115256, LA 115263, and LA 126181 probably reflects several factors. First, LA 115256 and LA 115263 date prior to the Doña Ana phase, before maize farming had

**Table 26.2 Culturally Significant Phytolith Data**

| Site Control | Feature # | Feature Type Control | PNUM | Depth (cm b. datum) | *Phaseolus* | *Zea Mays* (Cobs) | N | Conc[1] |
|---|---|---|---|---|---|---|---|---|
| LA 6829 | 41 (1 on bag) | 318 | 99.33–99.13 | | 91 | 1,824 | 510 | 10212 |
| LA 6829 | 38 | Floor Scape from Structure 6 | 999 | 97.94 | | | 74 | 864 |
| LA 6829 | 41 | Large Thermal Feature | 318 | 99.33–99.13 | | | 91 | 1824 |
| LA 6829 | 54.16 | Storage Pit in Structure 1 | 1608 | 98.1 | | | 69 | 1197 |
| LA 6829 | 85 | Large Thermal Feature | 1170 | | | | 415 | 4704 |
| LA 6829 | 88 | Non-thermal Pit | 1090 | 98.32–98.00 | | | 47 | 623 |
| LA 6829 | 163 | Non-thermal Pit | 1460 | 98.6-98.56 | | | 49 | 916 |
| LA 6829 | 178 | Small Thermal Feature | 1692 | 64 | 1 | 6 | 1680 | 33445 |
| LA 6829 | 185 | Large Thermal Feature | 1733 | 98.14–98.11 | | | 129 | 2090 |
| LA 115256 | 3 | Large Thermal Feature | 19 | 100.01–99.85 | | | 264 | 4706 |
| LA 15260 | 1 | Midden | 125 | 98.90–98.80 | | | 172 | 3056 |
| LA 115260 | 1 | Midden | 127 | 98.80–98.70 | | | 34 | 424 |
| LA 115260 | 1A | Storage Pit (?) | 323 | 98.19 | | 5 | 303 | 5600 |
| LA 115263 | 2 | Hearth | 6 | 99.57–99.46 | | | 80 | 1378 |
| LA 115265 | 1 | Hearth | 51 | 99.33–99.2 | | 3 | 730 | 12061 |
| LA 126181 | 4 | Large Thermal Feature | 118 | 100.01–99.88 | | | 415 | 8173 |

[1] Concentration of phytoliths per gram of sediment processed.



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become a substantial component of the subsistence economy.  Moreover, the remains at these sites reflect small-scale, low-intensity occupations, and activities carried out here may have been limited. LA 126181 is a Doña Ana-phase site, but like LA 115256 and LA 115263, is a small-scale, possibly task-specific site.  These smaller, shorter-term occupations may not have involved the use of cultigens, or otherwise did not result in the deposition of culturally significant archaeobotanical remains in detectable quantities or concentrations.  Finally, there is the problem of small sample size from these sites; only one sediment sample from each was submitted for phytolith analysis.  In the case of LA 115263, poor preservation may be a factor, as the single sample from this site produced a low phytolith concentration.  Preservation does not appear to have been a factor at LA 115262 or LA 126181, as the samples from these sites each contain high phytolith concentrations, and this, along with the absence or paucity of economically significant plant taxa in the macrobotanical assemblages (see Chapter 24), reinforces the likelihood that past subsistence practices and/or limited, task-specific occupations can account for the absence of preserved subsistence plant remains at these sites.

Chapter 27

# DIATOMS

*Barbara Winsborough and Jim A. Railey*

## Introduction

Diatoms are single celled algae with a siliceous cell wall. They grow in a wide range of aerophilous habitats, including damp soils, wet plants and rocks, marshes, wetlands and mudflats as well as in all types of standing and flowing aquatic habitats. Their silica cells are often preserved in sedimentary deposits. Because individual taxa have specific requirements and preferences with respect to water chemistry, hydrologic conditions and substrate characteristics, the presence of diatoms in paleoenvironmental context can provide information about the nature of the local environment. These data, coupled with input about local geology and hydrology, soil characteristics, pollen, and phytoliths provide evidence of the paleoenvironmental setting.

Diatom analysis for the US 54 project was motivated primarily to investigate the possibility that some of the larger pit features at the Jaca site (LA 6829) might be water retention facilities, or *huecos* (see Chapter 6). Accordingly, most of the samples submitted came from possible *hueco* features (Features 58, 82, 86, 89, 90, 116, 120, and 147). In addition, two samples were submitted from the large, communal structure complex, Feature 54; one came from the floor of the lower pithouse (Structure 2, PNUM 1667), and one from the floor of the overlying, large surface room (Structure 1, PNUM 1119). Also, a sample was submitted from LA 115260, Feature 1A, one of the pits underlying the sheet midden (Feature 1) at that site.

## Methods

Samples were cleaned of organic material and acid-soluble minerals in preparation for microscopic analysis by boiling first in hydrogen peroxide and then in nitric acid. The oxidized, decalcified material was rinsed repeatedly until a pH of about 6–7 was reached. A few drops of the cleaned material was air-dried on to glass coverslips and mounted on glass slides using HYRAX, a resin with a high index of refraction. Slides were scanned at 1500x in their entirety and all of the diatoms were recorded.

## Results and Discussion

All but one of the samples (site LA 6829, PNUM 1355, Feature 82) contained diatom remains, although very few cells were found in most of the samples. The diatom remains were heavily diluted with sediment. The diatom data are presented in Table 27.1. There is a mixture of aerial (soil and mud) and aquatic diatoms in the samples, the diatom cells are not all equally well preserved, and some are broken. The aerial diatoms include *Hantzschia amphioxys*, *Luticola mutica*, *Pinnularia borealis* and *Pinnularia microstauron*. These species are typically found in periodically wetted soils and on mud surfaces. *P. microstauron* is found on soils around the roots of plants and also in shallow, oligotrophic, low electrolyte, oxygen-rich, slightly acid to circumneutral pH water. The cells of this diatom were particularly well preserved and were probably not transported very far.

The aquatic diatoms are all benthic species, (except possibly *Cyclotella glomerata*) living attached to rocks or plants. Many of them are typically found in very shallow, slightly alkaline, oligotrophic water or a thin film of flowing water. They are also early colonizing species suggesting that they may have been living in an environment that was only seasonally wet. *Fragilaria tenera*, the most common and ubiquitous diatom species in the analyzed samples, prefers slow-moving,

low-conductivity water, but *Encyonema evergladianum* and *Denticula kuetzingii* are usually found in circum-neutral to slightly alkaline, carbonate-rich water. The other species are rather broad in their ecological tolerances but none of the species are characteristic of soft water, acidic bogs or swamps and none of the taxa are indicative of deep, turbid, eutrophic or saline water.

In terms of diatom frequencies and distributions, samples from the possible *hueco* features at the Jaca site yielded from 0–20 specimens per analyzed sample. The majority of species represented were aquatic diatoms, which occurred in all the large pit samples at Jaca, with the exception of Feature 82 (which yielded no diatoms) and Feature 116, which produced only two specimens of the aerial diatom *Hantzschia amphioxys*. Among the large pits at Jaca, Feature 147 yielded the highest frequency of diatoms (n=20), followed by Feature 89 (n=19), and Feature 58 (n=13). Samples from these three pits also produced the greatest diversity of diatoms (five species represented in each of these features) among the possible hueco features at Jaca. Features 89 and 147 also exhibit similar rosters of diatom species (four species occur in both of these samples), with the species composition in Feature 58 being somewhat dissimilar, sharing only two of its five species with Features 89 and/or 147. Interestingly, none of these three large pits are in close proximity to each other; Feature 89 was approximately 10 m northeast of Feature 147, and Feature 58 lies nearly 40 m south of Feature 147 in the southern cluster of pithouses within the Jaca site core area.

Of these three large pit features, only Feature 89 was located within the tight cluster of large, possible *hueco* features just east of Feature 54 (the communal structure complex). Interestingly, however, the other possible *huecos* in this cluster (Features 82, 86, 90, 116, and 120) yielded extremely low frequencies of diatoms, with a range of 0–5 specimens. Feature 116, the largest of the possible hueco pits at Jaca, was the only one that did not yield any aquatic diatoms.

Two samples from Jaca site Feature 54, the communal structure complex, yielded interesting and very dissimilar diatom assemblages. The sample from the floor of Structure 2 (the underlying pithouse) yielded only two aerial diatoms. In contrast, the sample from the floor of the overlying Structure 1 yielded the richest diatom assemblage among the samples submitted for analysis, in terms of both frequency (n=28) and species diversity (n=9). Moreover, in contrast to the sample from the Structure 2 floor, all of the diatoms in the Structure 1 floor sample were aquatic species. These include the only occurrence in the US 54 samples of *Encyonema evergladianum* and *Denticula kuetzingii*, which are usually found in alkaline, carbonate-rich water. The Structure 1 floor sample suggests any combination of four possibilities. First, following abandonment of Structure 1, the house basin may have filled with water (however briefly), creating conditions favorable to the various species of early-colonizing diatoms found in this sample. Second, the diatoms found in Structure 1 may have been re-deposited inside the structure as a result of domestic activities that made use of water collected elsewhere on or near the site, possibly from several different sources. Third, the diatoms may have been inclusive in the midden debris that was dumped into this portion of Structure 1 following abandonment; in this scenario, the diatoms may have been re-deposited here in waste water thrown into the abandoned structure basin, and/or within midden soils. This presumes the presence of a nearby water source to provide diatom innoculant, which could get to the site by wind or animal transport. Fourth, as diatoms are common in animal dung and some bird nesting material (mud), occupation of the abandoned site by mammals, rodents, or swallows could result in the accumulation of diatomaceous dung, guano, or mud in the local sediment.

Finally, the single sample from LA 115260 yielded three specimens of the aquatic diatom *Fragilaria tenera,* which was also the most frequent and ubiquitous species encountered in the US 54 samples.



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Although the results show an interesting degree of variation between different samples, it is important to keep in mind that all of the samples yielded low concentrations of diatoms. The abundance of sediment in proportion to diatoms suggests that the material containing aquatic diatoms represents microenvironments with high rates of sedimentation. In this sense, the habitats mimic conditions found in an overbank floodplain setting, albeit on a micro-scale. As noted above for the Structure 1 floor sample (but perhaps equally true for at least some of the potential *hueco* features), it is also possible that the diatoms are secondary, being dumped onto the sediments after deposition, during cooking, washing or other domestic activities.

Although not conclusive, the diatom species identified in the US 54 features are potentially consistent with the sorts of aquatic microenvironments that would likely have existed in large-pit, water-retention facilities or *huecos*. These pits were probably filled with water only seasonally, and probably had high rates of sedimentation (perhaps requiring periodic dredging, but which was also probably managed through digging of small, subfloor pits at the bottoms of the large *huecos*; see Chapter 6). Moreover, the caliche layer, into which at least some of these pits were dug into, probably contributed to the slightly alkaline water conditions favored by most of the aquatic diatoms identified in the samples. Still, the presence of diatoms in other features that clearly were not *huecos* (and the complete absence of diatoms in one of the possible *huecos* at Jaca) indicates that the conditions and circumstances of diatom colonization and deposition within the US 54 sites were probably quite varied, both during site occupation and following the abandonment of individual features and settlements.

**Table 27.1 Diatom Abundance**

| Site | LA 6829 | | | | | | | | | LA 115260 |
|---|---|---|---|---|---|---|---|---|---|---|
| PNUM: | 1091 | 1112 | 1119 | 1280 | 1411 | 1663 | 1667 | 1748 | 1813 | 323 |
| Feature: | 86 | 90 | 54 | 58 | 120 | 89 | 54 | 147 | 116 | 1A |
| *Achnanthes biasolettiana* | | | 3 | 1 | | | | | | |
| *Achnanthidium minutissimum* | | | 1 | 2 | | | | | | |
| *Cyclotella glomerata* | | | | | | 1 | | 6 | | |
| *Cocconeis placentula* | | | 6 | | | | | | | |
| *Denticula kuetzingiana* | | | 5 | | | | | | | |
| *Encyonema evergladianum* | | | 4 | | | | | | | |
| *Fragilaria capucina* | | | 1 | | | | | | | |
| *Fragilaria construens* | | | 5 | | | | | | | |
| *Fragilaria tenera* | 4 | | | 5 | 2 | 11 | | 2 | | 3 |
| *Fragilaria ulna* | | | 1 | 3 | | 1 | | | | |
| *Gomphonema insigniforme* | | | 2 | | | | | | | |
| *Hantzschia amphioxys* | | 2 | | 2 | | | 1 | | 2 | |
| *Luticola mutica* | | | | | | | 1 | | | |
| *Navicula radiosa* | | | | | | | | 1 | | |
| *Nitzschia palea* | | 2 | | | | 3 | | 4 | | |
| *Pinnularia borealis* | | 1 | | | | | | | | |
| *Pinnularia microstauron* | | | | | | 3 | | 7 | | |
| Total | 4 | 5 | 28 | 13 | 2 | 19 | 2 | 20 | 2 | 3 |



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Chapter 28

# LIPID RESIDUES

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## Introduction

A total of 17 fire-cracked rocks (FCR) and one potsherd from four sites in the US 54 project (LA 6829, LA 128699, LA 128700, and LA 128708) was submitted for analysis. Where necessary, subsamples were taken; for sample NM 8, the area of the rock to be sampled was indicated with an "x." Exterior surfaces were ground off to remove any contaminants. Samples were powdered and absorbed lipid residues were extracted with organic solvents. Fatty acid components of the lipid extracts were analyzed using gas chromatography. Residues were identified using criteria developed from the decomposition patterns of experimental residues. The first section of this report outlines the development of the identification criteria. Following this, analytical procedures and results are presented.

## Fatty Acids and Development of the Identification Criteria

### *Introduction and Previous Research*

Fatty acids are the major constituents of fats and oils (lipids) and occur in nature as triglycerides, consisting of three fatty acids attached to a glycerol molecule by ester-linkages. The shorthand convention for designating fatty acids, Cx:yωz, contains three components. The "Cx" refers to a fatty acid with a carbon chain length of x number of atoms. The "y" represents the number of double bonds or points of unsaturation, and the "ωz" indicates the location of the most distal double bond on the carbon chain, i.e., closest to the methyl end. Thus, the fatty acid expressed as C18:1ω9 refers to a mono-unsaturated isomer with a chain length of 18 carbon atoms with a single double bond located nine carbons from the methyl end of the chain. Similarly, the shorthand designation, C16:0, refers to a saturated fatty acid with a chain length of 16 carbons.

Their insolubility in water and relative abundance compared to other classes of lipids, such as sterols and waxes, make fatty acids suitable for residue analysis. Since employed by Condamin *et al.* (1976), gas chromatography has been used extensively to analyze the fatty acid component of absorbed archaeological residues. The composition of uncooked plants and animals provides important baseline information, but it is not possible to directly compare modern uncooked plants and animals with highly degraded archaeological residues. Unsaturated fatty acids, which are found widely in fish and plants, decompose more readily than saturated fatty acids, sterols or waxes. In the course of decomposition, simple addition reactions might occur at points of unsaturation (Solomons 1980) or peroxidation might lead to the formation of a variety of volatile and non-volatile products which continue to degrade (Frankel 1991). Peroxidation occurs most readily in fatty acids with more than one point of unsaturation.

Several attempts have been made to identify archaeological residues using criteria that discriminate uncooked foods (Marchbanks 1989; Skibo 1992; Loy 1994). Marchbanks' (1989) percent of saturated fatty acids (%S) criteria has been used to identify residues from a variety of materials including pottery, stone tools, and burned rocks (Marchbanks 1989; Marchbanks and Quigg 1990; Collins *et al.* 1990). Skibo (1992:89) could not apply the %S technique and instead used two ratios of fatty acids, C18:0/C16:0 and C18:1/C16:0. He reported that it was possible to link the uncooked foods with residues extracted from modern cooking pots actively used to prepare one type of food; howev-



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er, the ratios could not identify food mixtures. The utility of these ratios did not extend to residues extracted from archaeological potsherds because the ratios of the major fatty acids in the residue changed with decomposition (Skibo 1992:97). Loy (1994) proposed the use of a Saturation Index (SI), determined by the ratio: SI = 1-[(C18:1+C18:2)/C12:0+C14:0+C16:0 +C18:0)]. He admitted, however, that poorly understood decompositional changes to the original suite of fatty acids make it difficult to develop criteria for distinguishing animal and plant fatty acid profiles in archaeological residues.

The major drawback of the distinguishing ratios proposed by Marchbanks (1989), Skibo (1992) and Loy (1994) is that the ratios have never been empirically tested. The proposed ratios are based on criteria that discriminate food classes on the basis of their original fatty acid composition. The resistance of these criteria to the effects of decompositional changes has not been demonstrated. Rather, Skibo (1992) found his fatty acid ratio criteria could not be used to identify highly decomposed archaeological samples.

In order to identify a fatty acid ratio unaffected by degradation processes, Patrick *et al.* (1985) simulated the long-term decomposition of one sample and monitored the resulting changes. An experimental cooking residue of seal was prepared and degraded in order to identify a stable fatty acid ratio. Patrick *et al.* (1985) found that the ratio of two C18:1 isomers, oleic and vaccenic, did not change with decomposition; this fatty acid ratio was then used to identify an archaeological vessel residue as seal. While the fatty acid composition of uncooked foods must be known, Patrick *et al.* (1985) showed that the effects of cooking and decomposition over long periods of time on the fatty acids must also be understood.

### ***Development of the Identification Criteria***

As the first stage in developing the identification criteria used herein, the fatty acid compositions of more than 130 uncooked Native food plants and animals from Western Canada were determined using gas chromatography (Malainey 1997; Malainey *et al.* 1999a). When the fatty acid compositions of modern food plants and animals were subject to cluster and principal component analyses, the resultant groupings generally corresponded to divisions that exist in nature (Table 28.1). Clear differences in the fatty acid composition of large mammal fat, large herbivore meat, fish, plant roots, greens, berries, seeds, and nuts were detected, but the fatty acid composition of meat from medium-sized mammals resembles berries, seeds, and nuts.

Samples in cluster A, the large mammal and fish cluster had elevated levels of C16:0 and C18:1 (Table 28.1). Divisions within this cluster stemmed from the very high level of C18:1 isomers in fat, high levels of C18:0 in bison and deer meat and high levels of very long chain unsaturated fatty acids (VCLU) in fish. Differences in the fatty acid composition of plant roots, greens, and berries/seeds/nuts reflect the amounts of C18:2 and C18:3ω3 present. The berry, seed, nut, and small mammal meat samples appearing in cluster B have very high levels of C18:2, ranging 35–64 percent (Table 28.1). Samples in subclusters V, VI, and VII have levels of C18:1 isomers from 29–51 percent, as well. Plant roots, plant greens, and some berries appear in cluster C. All cluster C samples have moderately high levels of C18:2; except for the berries in subcluster XII, levels of C16:0 are also elevated. Higher levels of C18:3ω3 and/or very long chain saturated fatty acids (VLCS) are also common except in the roots which form subcluster XV.

Secondly, the effects of cooking and degradation over time on fatty acid compositions were examined. Originally, 19 modern residues of plants and animals from the plains, parkland and forests of Western Canada were prepared by cooking samples of meats, fish and plants, alone or combined, in replica vessels over an open fire (Malainey 1997; Malainey *et al.* 1999b). After four days at room temperature, the vessels were broken and a set of sherds analysed to determine changes after a short term of decomposition. A



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**Table 28.1 Summary of Average Fatty Acids Compositions of Modern Food Groups Generated by Hierarchical Cluster Analysis**

| Cluster | A | | | | B | | | | | | C | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Subcluster** | **I** | **II** | **III** | **IV** | **V** | **VI** | **VII** | **VIII** | **IX** | **X** | **XI** | **XII** | **XIII** | **XIV** | **XV** |
| **Type** | Mammal Fat and Marrow | Large Herbivore Meat | Fish | Fish | Berries and Nuts | Mixed | Seeds and Berries | Roots | Seeds | Mixed | Greens | Berries | Roots | Greens | Roots |
| **C16:0** | 19.9 | 19.39 | 16.07 | 14.1 | 3.75 | 12.06 | 7.48 | 19.98 | 7.52 | 10.33 | 18.71 | 3.47 | 22.68 | 24.19 | 18.71 |
| **C18:0** | 7.06 | 20.35 | 3.87 | 2.78 | 1.47 | 2.36 | 2.58 | 2.59 | 3.55 | 2.43 | 2.48 | 1.34 | 3.15 | 3.66 | 5.94 |
| **C18:1** | 56.77 | 35.79 | 18.28 | 31.96 | 51.14 | 35.29 | 29.12 | 6.55 | 10.02 | 15.62 | 5.03 | 14.95 | 12.12 | 4.05 | 3.34 |
| **C18:2** | 7.01 | 8.93 | 2.91 | 4.04 | 41.44 | 35.83 | 54.69 | 48.74 | 64.14 | 39.24 | 18.82 | 29.08 | 26.24 | 16.15 | 15.61 |
| **C18:3** | 0.68 | 2.61 | 4.39 | 3.83 | 1.05 | 3.66 | 1.51 | 7.24 | 5.49 | 19.77 | 35.08 | 39.75 | 9.64 | 17.88 | 3.42 |
| **VLCS** | 0.16 | 0.32 | 0.23 | 0.15 | 0.76 | 4.46 | 2.98 | 8.5 | 5.19 | 3.73 | 6.77 | 9.1 | 15.32 | 18.68 | 43.36 |
| **VLCU** | 0.77 | 4.29 | 39.92 | 24.11 | 0.25 | 2.7 | 1 | 2.23 | 0.99 | 2.65 | 1.13 | 0.95 | 2.06 | 0.72 | 1.1 |

VLCS- Very Long Chain (C20, C22 and C24) Saturated Fatty Acids

VLCU - Very Long Chain (C20, C22 and C24) Unsaturated Fatty Acids



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second set of sherds remained at room temperature for 80 days, then placed in an oven at 75° C for a period of 30 days in order to simulate the processes of long term decomposition. The relative percentages were calculated on the basis of the ten fatty acids (C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1ω9, C18:1ω11, C18:2) that regularly appeared in Precontact Period vessel residues from Western Canadian. Observed changes in fatty acid composition of the experimental cooking residues enabled the development of a method for identifying the archaeological residues (Table 28.2).

It was determined that levels of medium chain fatty acids (C12:0, C14:0 and C15:0), C18:0, and C18:1 isomers in the sample could be used to distinguish degraded experimental cooking residues (Malainey 1997; Malainey *et al.* 1999b). These fatty acids are suitable for the identification criteria because saturated fatty acids are stable and the mono-unsaturated fatty acid degrades very slowly, as compared to polyunsaturated fatty acids (deMan 1992). Higher levels of medium chain fatty acids, combined with low levels of C18:0 and C18:1 isomers, were detected in the decomposed experimental residues of plants, such as roots, greens, and most berries. High levels of C18:0 indicated the presence of large herbivores. Moderate levels of C18:1 isomers, with low levels of C18:0, indicated the presence of either fish or foods similar in composition to corn. High levels of C18:1 isomers with low levels of C18:0 were found in residues of beaver or foods of similar fatty acid composition. The criteria for identifying six types of residues were established experimentally; the seventh type, plant with large herbivore, was inferred (Table 28.2). These criteria were applied to residues extracted from more than 200 pottery cooking vessels from 18 Western Canadian sites (Malainey 1997; Malainey *et al.* 1999c, 2001b). The identifications were found to be consistent with the evidence from faunal and tool assemblages for each site.

Work has continued to understand the decomposition patterns of various foods and food combinations (Malainey *et al.* 2000a, 2000b, 2000c, 2001a; Quigg *et al.* 2001). The collection of modern foods has expanded to include plants from the Southern Plains. The fatty acid compositions of mesquite beans (*Prosopis glandulosa*), Texas ebony seeds (*Pithecellobium ebano Berlandier*), tasajillo berry (*Opuntia leptocaulis*), prickly pear fruit and pads (*Opuntia engelmannii*), Spanish dagger pods (*Yucca treculeana*), cooked sotol (*Dasylirion wheeler*), agave (*Agave lechuguilla*), cholla (*Opuntia imbricata*), piñon (*Pinus edulis*), and Texas mountain laurel (or mescal) seed (*Sophora secundiflora*) have been determined. Experimental residues of many of these plants, alone or in combination with deer meat, have been prepared by boiling foods in clay cylinders or using sandstone for either stone boiling (Quigg 1999) or as a griddle. In order to accelerate the processes of oxidative degradation that naturally occur at a slow rate with the passage of time, the rock or clay tile containing the experimental residue was placed in an oven at 75° C. After either 30 or 68 days, residues were extracted and analysed using gas chromatography.

The results of these decomposition studies enabled refinement of the identification criteria.

**Table 28.2 Criteria for the Identification of Archaeological Residues Based on the Decomposition Patterns of Experimental Cooking Residues Prepared in Pottery Vessels**

| Identification | Medium Chain | C18:0 | C18:1 isomers |
|---|---|---|---|
| Large herbivore | ≤ 15% | ≥ 27.5% | ≤ 15% |
| Large herbivore with plant OR Bone Marrow | Low | ≥ 25% | 15% ≤ *X* ≤ 25% |
| Plant with large herbivore | ≥ 15% | ≥ 25% | No data |
| Beaver | Low | Low | ≥ 25% |
| Fish or Corn | Low | ≤ 25% | 15% ≤ *X* ≤ 27.5% |
| Fish or Corn with Plant | ≥ 15% | ≤ 25% | 15% ≤ *X* ≤ 27.5% |
| Plant (except corn) | ≥ 10% | ≤ 27.5% | ≤ 15% |



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## Methodology

Descriptions of the 18 samples are presented in Table 28.3. Possible contaminants were removed by grinding off exterior surfaces with a Dremel® tool fitted with a silicon carbide bit. Immediately thereafter, the sample was crushed with a hammer mortar and pestle and the powder transferred to an Erlenmeyer flask. Lipids were extracted using a variation of the method developed by Folch *et al.* (1957). The powdered sample was mixed with a 2:1 mixture, by volume, of chloroform and methanol (2 x 30 mL) using ultrasonication (2 x 10 min). Solids were removed by filtering the solvent mixture into a separatory funnel. The lipid/solvent filtrate was washed with 16 mL of double distilled water. Once separation into two phases was complete, the lower chloroform-lipid phase was transferred to a round-bottomed flask and the chloroform removed by rotary evaporation. Any remaining water was removed by evaporation with benzene (1.5 mL); 1.5 mL of chloroform-methanol (2:1) was used to transfer the dry total lipid extract to a screw-top glass vial with a Teflon®-lined cap. The sample was flushed with nitrogen and stored in a -20° C freezer.

A 450-mL sample of the total lipid extract solution was placed in a screw-top test tube and dried in a heating block under nitrogen. Fatty acid methyl esters (FAMES) were prepared by treating the dry lipid with 6 mL of 0.5 N anhydrous hydrochloric acid in methanol (65–70° C; 60 min). Fatty acids that occur in the sample as di- or triglycerides are detached from the glycerol molecule and converted to methyl esters. After cooling to room temperature, 4 mL of ultrapure water was added. FAMES were recovered with petroleum ether (3 mL) and transferred to a vial. The solvent was removed by heat under a gentle stream of nitrogen; the FAMES were dissolved in 75 µL of iso-octane transferred to a GC vial with a conical glass insert.

Solvents and chemicals were checked for purity by running a sample blank. The entire lipid extraction and methyl esterification process was performed and FAMES were dissolved in 75 mL of iso-octane. Traces of contamination were subtracted from the sample chromatogram. The relative percentage composition was calculated by dividing the integrated peak area of each fatty acid by the total area of fatty acids present in the sample. Moderate levels (~20%) of C18:3ω3

**Table 28.3 List of Samples Analyzed from TRC Project 27836**

| Lab No. | Site | Sample No. | Feature | Feature Type | Material | Sample Size (g) |
|---|---|---|---|---|---|---|
| NM 1 | 6829 | 106 | 43 | Thermal | Burned rock | 23.48 |
| NM 2 | 6829 | 1155 | 89 | Pit | Sherd | 13.12 |
| NM 3 | 6829 | 1566 | 164 | Thermal | Burned rock | 28.4 |
| NM 4 | 6829 | 1575 | 54.13 | Post hole | Burned rock | 44.33 |
| NM 5 | 6829 | 1731 | 185 | Thermal | Burned rock | 32.54 |
| NM 6 | 6829 | 1816 | 179 | structure | Burned rock | 33.6 |
| NM 7 | 128699 | 308 | 28 | Thermal | Burned rock | 35.22 |
| NM 8 | 128699 | 353 | 3 | Thermal | Burned rock | 48.28 |
| NM 9 | 128699 | 495 | 55 | Thermal | Burned rock | 36 |
| NM 10 | 128699 | 533 | 82 | Thermal | Burned rock | 39.7 |
| NM 11 | 128699 | 547 | 33 | Thermal | Burned rock | 31.13 |
| NM 12 | 128699 | 554 | 33 | Thermal | Burned rock | 31.85 |
| NM 13 | 128699 | 565 | 25 | Thermal | Burned rock | 36.2 |
| NM 14 | 128699 | 578 | 81 | Thermal | Burned rock | 38.37 |
| NM 15 | 128699 | 585 | 70 | Thermal | Burned rock | 41.57 |
| NM 16 | 128700 | 743 | 29 | Thermal | Burned rock | 47.04 |
| NM 17 | 128708 | 78 | 2 | Thermal | Burned rock | 34.36 |
| NM 18 | 128708 | 90 | 44 | Thermal | Burned rock | 45.84 |



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appeared in the residue extracted from NM 16. Much lower levels of this polyunsaturated fatty acid appear in other samples; the obvious contaminant was reduced to the average level observed in other samples prior to the calculation of relative percentage composition.

The step in the extraction procedure where the chloroform, methanol and lipid mixture is washed with water is standard procedure for the extraction of lipids from modern samples. Following Evershed *et al.* (1990), who reported that this step was unnecessary for the analysis of archaeological residues, previously the solvent-lipid mixture was not washed. This step was recently adopted to remove impurities so that a clearer chromatogram could be obtained in the region where very long chain fatty acids (C20:0, C20:1, C22:0, and C24:0) occur. It was anticipated that the detection and accurate assessment of these fatty acids could be instrumental in separating residues of animal origin from those of plant (Malainey *et al.* 2000a, 2000b, 2000c, 2001a).

In order to identify the residue, the relative percentage composition was determined first with respect to all fatty acids present in the sample (including very long chain fatty acids) (see Table 28.4) and secondly with respect to the ten fatty acids utilized in the development of the identification criteria (C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1ω9, C18:1ω11, and C18:2) (not shown). The second step is necessary for the application of the identification criteria in Table 28.2.

It must be understood that the identifications given do not necessarily mean that those particular foods were actually prepared because different foods of similar fatty acid composition and lipid content would produce similar residues. It is possible only to say that the material of origin for the residue was similar in composition to the food(s) indicated.

#### ***Gas Chromatography Analysis Parameters***

The GC analysis was performed on a Hewlett-Packard 5890 gas chromatograph fitted with a flame ionization detector connected to a personal computer. Samples were separated using a DB-23 fused silica capillary column (30 m x 0.25 mm I.D.; J&W Scientific; Folsom, CA). An autosampler injected a 3 mL sample using a split injection system with the ratio set at 1:20. Hydrogen was used as the carrier gas at a linear velocity of approximately 40 cm/sec. Column temperature was programmed from 155–215° C at 2° C per minute. The lower temperature was held for 4 minutes; the upper temperature was held for 15 minutes. The chromatogram peaks were integrated using ChromPerfect® software and identified through comparisons with several external qualitative standards (NuCheck Prep; Elysian, MN). Using this procedure, fatty acids are detectable to the nanogram (1 x 10-9 g) level.

### Results of Archaeological Data Analysis

The fatty acid compositions of residues extracted from 16 samples are presented in Table 28.4. Insufficient fatty acids were recovered from two FCR samples from site LA 6829, NM 3 and NM 4, to attempt a firm identification. The term "Area" represents the area under the chromatographic peak of a given fatty acid, as calculated by the ChromPerfect® software minus the solvent blank. The term "Rel%" represents the relative percentage of a particular fatty acid chain with respect to the total fatty acids in the sample. Hydroxide or peroxide degradation products can interfere with the integration of the C22:0 and C22:1 peaks; these fatty acids were excluded from the analysis.

The amount of residue recovered from the remaining samples was quite variable. Relatively high amounts of lipid residue were recovered from NM 2 and NM 7; relatively little lipid residue was recovered from NM 5, 6, 9, 11, and 17. Only one residue sample, NM 2 , extracted from the potsherd, is consistent with the preparation of large herbivore products, possibly in combination with plants. The remaining residues appear to result from the preparation of a range of

**Table 28.4 Fatty Acid Composition and Identification of Residues from TRC Project 27836**

| Fatty acid | NM 1 | | NM 2 | | NM 5 | | NM 6 | |
|---|---|---|---|---|---|---|---|---|
| | Area | Rel% | Area | Rel% | Area | Rel% | Area | Rel% |
| C12:0 | 1043 | 1.01 | 0 | 0 | 1148 | 3.58 | 199 | 0.43 |
| C14:0 | 3972 | 3.83 | 838 | 0.36 | 683 | 2.13 | 2637 | 5.69 |
| C14:1 | 97 | 0.09 | 0 | 0 | 0 | 0 | 154 | 0.33 |
| C15:0 | 1124 | 1.08 | 1176 | 0.5 | 313 | 0.98 | 466 | 1 |
| C16:0 | 19804 | 19.11 | 102895 | 43.65 | 12530 | 39.12 | 12254 | 26.42 |
| C16:1 | 459 | 0.44 | 286 | 0.12 | 387 | 1.21 | 580 | 1.25 |
| C17:0 | 0 | 0 | 6525 | 2.77 | 0 | 0 | 0 | 0 |
| C17:1 | 359 | 0.35 | 1338 | 0.57 | 242 | 0.76 | 1099 | 2.37 |
| C18:0 | 6826 | 6.59 | 65789 | 27.91 | 1785 | 5.57 | 419 | 0.9 |
| C18:1s | 65130 | 62.85 | 31053 | 13.17 | 6691 | 20.89 | 22324 | 48.13 |
| C18:2 | 2540 | 2.45 | 2982 | 1.26 | 4538 | 14.17 | 2830 | 6.1 |
| C18:3ω3 | 1213 | 1.17 | 3441 | 1.46 | 2557 | 7.98 | 2936 | 6.33 |
| C20:0 | 690 | 0.67 | 14640 | 6.21 | 1077 | 3.36 | 400 | 0.86 |
| C20:1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C24:0 | 376 | 0.36 | 4780 | 2.03 | 81 | 0.25 | 84 | 0.18 |
| C24:1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 103633 | 100 | 235743 | 100 | 32032 | 100 | 46382 | 100 |
| Identification | Very high fat content food (seed/animal fat or combination) | | Large Herbivore | | Medium fat content food (mesquite/corn) | | High fat content food (seed/animal fat or combination) | |

| Fatty acid | NM 7 | | NM 8 | | NM 9 | | NM 10 | |
|---|---|---|---|---|---|---|---|---|
| | Area | Rel% | Area | Rel% | Area | Rel% | Area | Rel% |
| C12:0 | 2385 | 0.92 | 335 | 0.55 | 1440 | 2.95 | 927 | 1.64 |
| C14:0 | 2653 | 1.02 | 3595 | 5.87 | 1451 | 2.97 | 663 | 1.17 |
| C14:1 | 0 | 0 | 563 | 0.92 | 118 | 0.24 | 0 | 0 |
| C15:0 | 1333 | 0.51 | 2132 | 3.48 | 1173 | 2.4 | 323 | 0.57 |
| C16:0 | 32422 | 12.46 | 16569 | 27.05 | 16572 | 33.97 | 14935 | 26.38 |
| C16:1 | 935 | 0.36 | 708 | 1.16 | 343 | 0.7 | 844 | 1.49 |
| C17:0 | 2084 | 0.8 | 0 | 0 | 1236 | 2.53 | 1339 | 2.37 |
| C17:1 | 2860 | 1.1 | 2087 | 3.41 | 1571 | 3.22 | 0 | 0 |
| C18:0 | 9805 | 3.77 | 7422 | 12.12 | 2891 | 5.93 | 6955 | 12.29 |
| C18: 1s | 157377 | 60.48 | 14245 | 23.25 | 12077 | 24.75 | 15216 | 26.88 |
| C18:2 | 35104 | 13.49 | 3508 | 5.73 | 4429 | 9.08 | 6784 | 11.98 |
| C18:3ω3 | 1593 | 0.61 | 3791 | 6.19 | 1060 | 2.17 | 245 | 0.43 |
| C20:0 | 3647 | 1.4 | 1753 | 2.86 | 1103 | 2.26 | 2422 | 4.28 |
| C20:1 | 255 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| C24:0 | 7753 | 2.98 | 4552 | 7.43 | 3323 | 6.81 | 5478 | 9.68 |
| C24:1 | 0 | 0 | 0 | 0 | 0 | 0 | 482 | 0.85 |
| Total | 260206 | 100 | 61260 | 100 | 48787 | 100 | 56613 | 100 |
| Identification | Very high fat content food (seed/animal fat or combination) | | Borderline medium and moderate-high fat content food | | Borderline medium and moderate-high fat content food | | Moderate-high fat content food (Texas ebony/beaver) | |



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**Table 28.4 Fatty Acid Composition and Identification of Residues from TRC Project 27836 (continued)**

| Fatty acid | NM 11 | | NM 12 | | NM 13 | | NM 14 | |
|---|---|---|---|---|---|---|---|---|
| | Area | Rel% | Area | Rel% | Area | Rel% | Area | Rel% |
| C12:0 | 298 | 0.69 | 2055 | 2.51 | 2281 | 2.68 | 373 | 0.47 |
| C14:0 | 2115 | 4.88 | 2121 | 2.59 | 1504 | 1.76 | 3309 | 4.15 |
| C14:1 | 272 | 0.63 | 157 | 0.19 | 30 | 0.04 | 362 | 0.45 |
| C15:0 | 1310 | 3.02 | 1084 | 1.33 | 769 | 0.9 | 1954 | 2.45 |
| C16:0 | 12549 | 28.95 | 23075 | 28.22 | 27958 | 32.81 | 24356 | 30.53 |
| C16:1 | 422 | 0.97 | 10725 | 13.12 | 2022 | 2.37 | 840 | 1.05 |
| C17:0 | 0 | 0 | 192 | 0.23 | 1115 | 1.31 | 2780 | 3.48 |
| C17:1 | 937 | 2.16 | 673 | 0.82 | 0 | 0 | 2043 | 2.56 |
| C18:0 | 4501 | 10.38 | 6092 | 7.45 | 3422 | 4.02 | 8296 | 10.4 |
| C18: 1s | 8021 | 18.5 | 19504 | 23.85 | 32302 | 37.9 | 13428 | 16.83 |
| C18:2 | 3171 | 7.31 | 7483 | 9.15 | 5527 | 6.49 | 5136 | 6.44 |
| C18:3ω3 | 4586 | 10.58 | 0 | 0 | 743 | 0.87 | 1961 | 2.46 |
| C20:0 | 1314 | 3.03 | 2432 | 2.97 | 1799 | 2.11 | 2735 | 3.43 |
| C20:1 | 0 | 0 | 0 | 0 | 455 | 0.53 | 0 | 0 |
| C24:0 | 3856 | 8.89 | 6183 | 7.56 | 4187 | 4.91 | 12212 | 15.31 |
| C24:1 | 0 | 0 | 0 | 0 | 1108 | 1.3 | 0 | 0 |
| Total | 43352 | 100 | 81776 | 100 | 85222 | 100 | 79785 | 100 |
| Identification | **Medium fat content food (mesquite/corn)** | | **Borderline medium and moderate-high fat content food** | | **Moderate-high fat content food (Texas ebony/beaver)** | | **Medium fat content food (mesquite/corn)** | |

| Fatty acid | NM 15 | | NM 16 | | NM 17 | | NM 18 | |
|---|---|---|---|---|---|---|---|---|
| | Area | Rel% | Area | Rel% | Area | Rel% | Area | Rel% |
| C12:0 | 3043 | 2.64 | 5417 | 4.06 | 197 | 0.39 | 2335 | 2.77 |
| C14:0 | 3191 | 2.77 | 7614 | 5.71 | 836 | 1.66 | 1907 | 2.26 |
| C14:1 | 262 | 0.23 | 459 | 0.34 | 0 | 0 | 0 | 0 |
| C15:0 | 1578 | 1.37 | 3680 | 2.76 | 850 | 1.69 | 1223 | 1.45 |
| C16:0 | 34134 | 29.64 | 39597 | 29.67 | 15388 | 30.52 | 28071 | 33.3 |
| C16:1 | 1356 | 1.18 | 586 | 0.44 | 508 | 1.01 | 731 | 0.87 |
| C17:0 | 190 | 0.16 | 0 | 0 | 151 | 0.3 | 814 | 0.97 |
| C17:1 | 0 | 0 | 2729 | 2.05 | 0 | 0 | 0 | 0 |
| C18:0 | 10222 | 8.88 | 14786 | 11.08 | 4301 | 8.53 | 10959 | 13 |
| C18:1s | 31975 | 27.76 | 32430 | 24.3 | 9937 | 19.71 | 10387 | 12.32 |
| C18:2 | 11595 | 10.07 | 8294 | 6.22 | 3730 | 7.4 | 5575 | 6.61 |
| C18:3ω3 | 1855 | 1.61 | 2000 | 1.5 | 1603 | 3.18 | 1173 | 1.39 |
| C20:0 | 2765 | 2.4 | 3241 | 2.43 | 2036 | 4.04 | 3819 | 4.53 |
| C20:1 | 412 | 0.36 | 0 | 0 | 0 | 0 | 0 | 0 |
| C24:0 | 11718 | 10.17 | 12604 | 9.45 | 10882 | 21.58 | 17294 | 20.52 |
| C24:1 | 876 | 0.76 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 115172 | 100 | 133437 | 100 | 50419 | 100 | 84288 | 100 |
| Identification | **Moderate-high fat content food (Texas ebony/beaver)** | | **Borderline medium and moderate-high fat content food** | | **Medium fat content food (mesquite/corn)** | | **Borderline medium and medium-low fat content food** | |

foods, from those of medium-low to very high fat contents. Elevated levels of medium and very long chain saturated fatty acids (VLCS), suggest many of these residues are of plant origin.

The fatty acid composition of two residue samples, NM 1 and NM 7, is consistent with very high fat content foods, such as seeds/nuts or rendered mammal fat (other than large herbivore). Piñon and bear fat are known to produce similar residues, but slightly elevated levels of medium chain saturated (for NM 1) and VLCS (for NM 7) fatty acids suggest foods of plant origin. The composition of residue sample NM 6 is similar, but the fat content of the food of origin was slightly lower. It was high, as opposed to very high. Again, seeds and nuts are better candidates than mammal fat due to elevated levels of medium chain saturated fatty acids. It is possible that some combination of medium-high and very high fat content food could produce similar residues.

Three residue samples (NM 10, 13, and 15) are typical of foods of moderate-high fat content. These residues have relatively high levels of C18:1 isomers and relatively low levels of C18:0. Examples of moderate-high fat content foods include Texas ebony seeds and the fatty meat of medium-sized mammals, such as beaver. Elevated levels of medium chain and very long chain saturated fatty acids in all of these residues suggest they are of plant origin.

Four residue samples (NM 5, 11, 14, and 17) appear to result from the preparation of medium fat content foods, such as mesquite or corn. This residue has elevated levels of C18:1 isomers and relatively lower levels of C18:0. Fish produces similar residues but given the highly elevated levels of very long chain, saturated fatty acids in NM 11, 14, and 17, plant origins are almost certain. A plant origin is also favored for residue NM 5. The fatty acid composition of another residue, NM 18, is very similar to NM 17; however, the C18:1 isomer levels are lower. Residue sample NM 18 falls on the border between medium and medium-low fat content foods. Foods of medium-low fat content include certain plant fruits, such as prickly pear tunas.

Four other residue samples (NM 8, 9, 12, and 16) fall on the border between medium and moderate-high fat content foods. Once again, elevated levels of medium chain and very long chain saturated fatty acids suggests the presence of plants. Residue sample NM 12 is somewhat different from the other residues in that the level of C16:1 is greater than 10 percent. Foods known to produce residues with elevated levels of C16:1 include freshwater fish and some birds, but the level of C14:0 should be higher if fish was prepared. It is possible that residue sample NM 12 is the result of a combination of bird and plant. In order to confirm this hypothesis, the preparation and simulated long term decomposition of an experimental cooking residue is necessary.

Of the six samples submitted from LA 6829, two pieces of FCR did not contain sufficient lipids for identification: NM 3 from a thermal feature and NM 4 from a posthole. Residue identifications from this site included one from foods of very high fat content, one from foods of high fat content, one from foods of medium fat content, and one of large herbivore, possibly in combination with plants.

All nine FCR samples submitted from LA 128699 contained sufficient residue for identification. Residue identifications included one prepared from foods of very high fat content, three from foods of moderate-high fat content, and two from foods of medium fat content. The remaining three residues fell on the border between medium and moderate-high fat content foods

The single FCR submitted from LA 128700, NM 16, fell on the border between medium and moderate-high fat content foods. The two FCR samples from LA 128708 were similar in that they both contained very high levels of C24:0. One residue was identified as food of medium fat content and the other fell on the border between medium and medium-low fat content foods.



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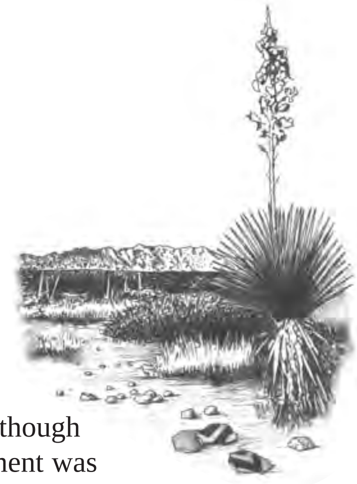
Chapter 29

# Human Remains

*Dee Jones-Bartholomew, John A. Torres, and Jim A. Railey*



The US 54 project recovered human remains from two of the data recovery sites: Jaca (LA 6829) and LA 115260. Two prehistoric human burials excavated at LA 6829, and the remains of four individuals were recovered at LA 115260. Both of these sites were excavated as part of archaeological data recovery efforts associated with US 54. All burial remains were analyzed by John A. Torres and Dee Jones-Bartholomew, using noninvasive laboratory osteological methods. Jim Railey produced the comparative discussion summarizing mortuary patterns in the southern Jornada Mogollon region. The list of skeletal elements by individual and the osteometrics for Feature 54.12 are located in Appendix J.

## Burial Features

Burial features were identified at LA 6829 only; the remains from LA 115260 were highly fragmentary and scattered, and were not identified during excavation. The two burial features at LA 6829 were designated Feature 54.9 and 54.12 and are subfeatures of Feature 54 (Structure 1), the large communal, early El Paso-phase structure (Figure 29.1). The remains from LA 115260 were scattered in Feature 1, a roughly 9 x 10-m midden with several associated, underlying pits.

### *LA 6829, Feature 54.9*

Feature 54.9 contained an 8-year-old juvenile of indeterminate gender. This individual was not interred in a pit, but rather was placed on the floor of the structure against the south wall. The burial was lying on its side in a flexed position, oriented west and facing north. The dimensions of this burial were 82 x 44 cm (east-west x north-south). The burial was contained within 11 cm of the structure floor. The majority of the individual is present, although in a highly fragmented condition. Burial goods were also lacking, although a ground stone fragment was found abutting the tibia bones at the east end and a chert hammerstone was just behind the skull to the southwest (Figure 29.1), although these may be fortuitous associations. The placement of this burial on the structure floor suggests 1) an event associated with the abandonment of the structure, or 2) burial within the midden fill deposited after the structure was abandoned. The lack of a recognizable, associated pit outline in the midden deposit would seem to indicate that the burial was placed on the structure floor prior to deposition of the midden. However, a pit outline may have preserved well within the midden fill (especially if the pit was filled with the same matrix as the surrounding midden), in which case excavation of a burial pit may be terminated once harder soil at the floor of Structure 1 was encountered.

### *LA 6829, Feature 54.12*

Feature 54.12, a 34–42-year-old male, was a burial pit excavated into the north central portion of the Structure 1 floor, roughly between the two main postholes. The burial pit was oval in plan, extending 97 x 50 cm (north-south x east-west). Its straight-sided walls extended down to a basin-shaped floor, 66 cm below the floor of Structure 1 (and cutting into the underlying pithouse, Structure 2). The fill was a brown (7.5YR5/4), sandy loam with a trace of charcoal and no other cultural evidence or inclusions. The pit was covered with floor matrix, indicating that the burial event occurred during, or just prior to, occupation and use of Structure 1.

The burial was in a flexed position (Figure 29.1) with the body oriented south to north with the

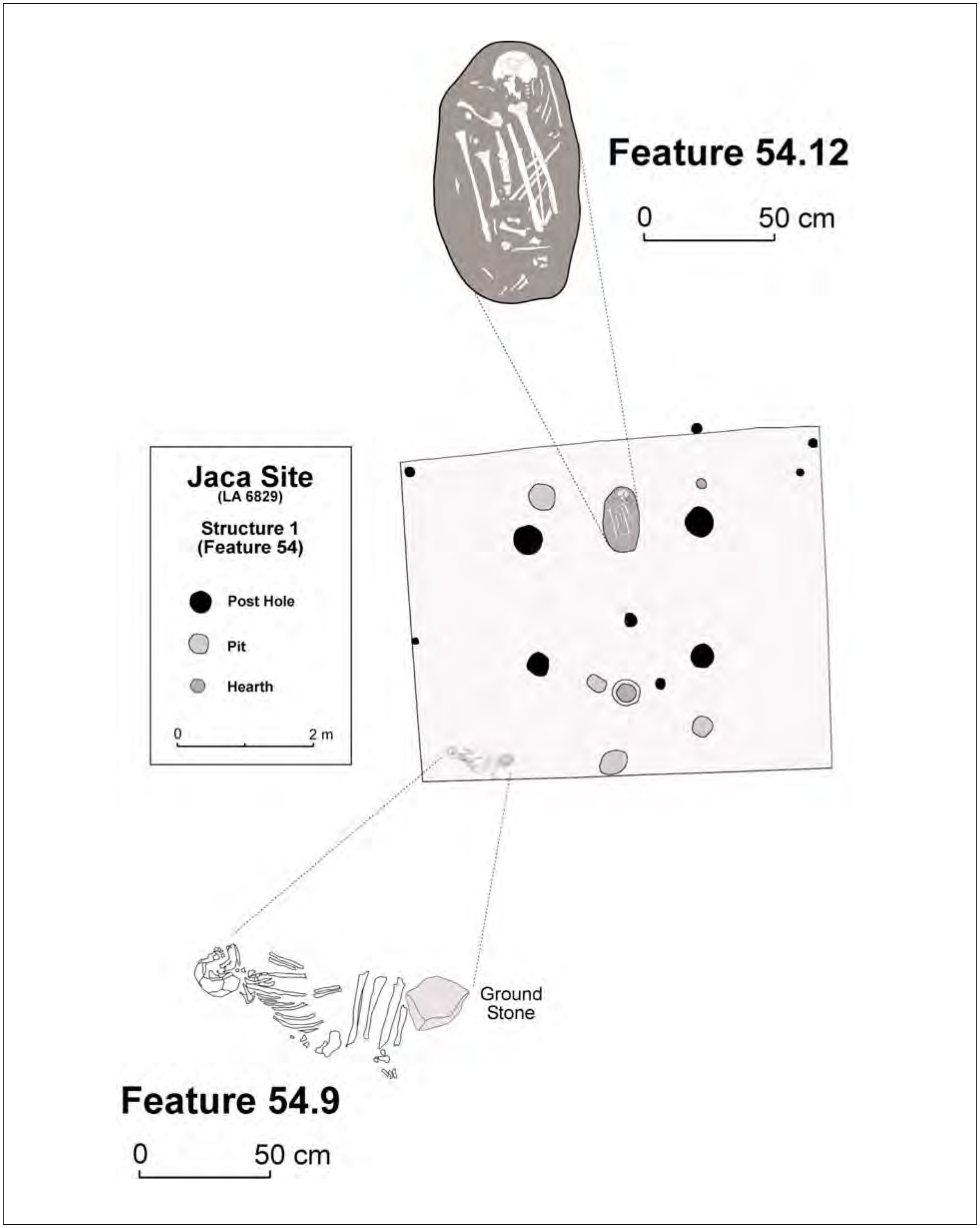



**Figure 29.1 Burial features at the Jaca site (LA 6829).**

head facing east. Post-depositional rodent activity had partially disturbed this individual. The most elevated portions of the burial were friable with preservation increasing near the base of the pit. Although the recovered remains were nearly complete.

## Osteological Analysis Methods

The laboratory methodology employed for this analysis was based on the standard osteological data recording techniques described by Buikstra and Ubelaker (1994) and those found to provide accurate information as used by Ms. Jones-Bartholomew during previous analyses (e.g., Jones 1996, 1997; Jones *et al.* 1998). The only exceptions are those limited by bone element condition and tribal wishes, which mandate that no destructive sampling of materials will occur.

### ***Number of Individuals***

The method of comparing diagnostic and definable elements, by examining non-repeating sides of the same elements, was employed in order to determine the number of individuals present in the collection. Comparisons were based on general size and robustness. This procedure is an essential first step in the analysis of any burial to determine the number of possible individuals present in an assemblage. This is especially important when human remains are recovered from a secondary or scattered context, such as those found at LA 155260. Bone identification during this analysis was supplemented by the use of Bass (1987) and White (1991).

#### Gender and Age Estimations

Standard osteological methods were used to estimate gender and age determinations (Bass 1987; Black 1978; Brothwell 1981; Gilbert and McKern 1973; Gustafson and Koch 1974; Hoffman 1979; Iscan and Loth 1986; Katz and Suchey 1986; Krogman and Iscan 1986; McKern and Stewart 1957; Phenice 1969; Steele and Brambett 1988; Stewart 1979; Suchey *et al.* 1986; Todd 1920; Ubelacker 1989; Webb and Suchey 1985). The most valuable element for determination of the gender and age of individual osteological remains is the pelvic bone, followed by cranial morphology and robusticity (sexing), epiphysial union (aging), dental development (aging), and changes to the sternal end of the fourth rib (aging). A more general, holistic examination of morphological traits was noted where these may indicate diagnostic sexual dimorphic characteristics, although the sample size is too small to make any clear determinations based on dimorphism alone. No attempt was made to assess the gender of juveniles, as secondary sex characteristics do not manifest until after puberty.

The methods for estimating biological age vary according to the developmental maturation of the individual. Children are much easier to age as the techniques used are based on dental development (Gustafson and Koch 1974; Ubelacker 1989), bone growth (Hoffman 1979), and epiphyseal union (Krogman and Iscan 1986), which provide relatively accurate results. As individual's age and growing ceases, age determination becomes less reliable, and involves more varied methods. Currently, the most accurate methods are based on changes to morphology of the pubic bone (Suchey *et al.* 1986) and the sternal end of the fourth rib (Iscan and Loth 1986). Pubic bone changes were also recorded using Gilbert and McKern (1973), McKern and Stewart (1957), Katz and Suchey (1986), Todd (1920), and Webb and Suchey (1985), to better evaluate the accuracy of the Suchey-Brooks method. Used together, these tools allow for a more precise method of aging adult individuals. When burials are not well preserved or are highly fragmented, age estimations become less precise. Other age estimation methods used include the fusion of the medial end of the clavicle (Webb and Suchey 1985), osteophytic growth on the vertebra and other auricular surfaces (Steele and Brambett 1988), and tooth loss/attrition (Brothwell 1981).

### ***Stature***

Several different methods were used to estimate stature, all based on long bone measurements of

the femur, tibia, humerus, radius and/or ulna. When long bones were not complete, or were heavily fragmented, methods pioneered by Steele (1970) and Steele and McKern (1969) were utilized. These methods used segment delineations to estimate long bone lengths and are particularly successful in estimated overall lengths. Once the maximum length was determined other methods for estimated stature were applied.

Two methods were employed to estimate stature (Genovés 1967; Trotter and Gleser 1952). Tables compiled by Genovés (1967) to estimate stature from remains recovered from Mesoamerican sites were used for comparison with femur and tibia lengths. Genovés method tends to underestimate the stature. Trotter and Gleser (1952) are based on black and white Korean War remains and tend to overestimate the stature. Although southwest populations have been studied extensively, no known published stature data exist.

#### ***Pathological Conditions***

During the analysis, the burial remains were examined for pathological conditions using standard comparative texts as a reference (Ortner and Putschar 1985; White 1991). Although this type of analysis is often done during excavation, it is recommended that an in-depth analysis should be done in the laboratory under controlled conditions. A low-power microscope was used to examine diagnostic elements for pathologies. Dentition and bone articular surfaces were the most extensively studied for the presence of pathologies. Cranial elements and dentition were also closely examined because of their established ability to yield evidence of nutritionally related pathologies (Steinbock 1976).

#### ***Metrics***

Linear measurements were taken only when such data could yield information about the individual's stature, sex, or age. Craniometric studies using measurements of the skull to estimate population of origin have been shown to be less than accurate, and were of only limited utility for this study as all cranial fragments were highly friable and fragmentary. Measurements were taken with metric digital calipers, craniometric spreading calipers, and a metric osteometric board.

### Examination of Material

Two phases of examination were performed in the analysis of these burial remains. Preliminary identification and classification was made during the first phase by sorting and separating the elements by type and side. General groups of diagnostic elements were made and were designated as follows: limb bones (e.g., long bones, patella, carpals, tarsals, metacarpals and metatarsals), vertebra, ribs and miscellaneous unidentifiable fragments. The second examination of the burial remains was more detailed. Each element was inspected for pathologies and other diagnostic features, beginning with the miscellaneous category. Elements initially placed in this group were positively identified as fragments of identified elements. After the analysis the elements were individually wrapped in natural-fabric textile and boxed by burial number in preparation for reinternment.

### Results of Skeletal Analysis

The following is a brief summary and description of all human remains identified during this investigation. The number of individuals present, their gender, age, and health including pathologies are outlined below.

The data generated by this analysis indicate that this collection contained at least five individuals. The remains of two individuals from intact burials and elements from the other individuals were in the form of scattered remains. When possible, estimated age and sex determinations were used to match unprovenienced elements to an individual.

#### ***LA 6829, Feature 54.9***

Feature 54.9 is a primary inhumation in a flexed position resting on its left side. The burial is incomplete and in a poor state of preservation due to the fragile nature of the elements. This burial represents a subadult approximately eight years of



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age (±24 months). Stature and sex could not be determined due to the young age of the individual. Similarly, no pathologies were observed; however, the overall general condition of the bone is consistent with a healthy individual. Cause of death could not be determined. The overall condition of the bone was very poor. This is primarily due to the young age of the individual at the time of death.

### Elements Present

Ossification and diaphysis-epiphysis fusing was absent from nearly all of the elements of this burial. Therefore, only a small portion of the potential elements was present (Figure 29.2). Most of the cranial bones are represented, although they are thin and fragile in nature. Post-depositional cranial deformation is present in the form of lateral compression, especially on the left side. Some lambdiodal flattening is present, which might indicate cradleboard deformation, but could also be a function of post-depositional processes. Both deciduous and permanent teeth were recovered (Figure 29.3). All of the long bones of both arms and legs are complete, however, all of the distal and proximal epiphyses are absent. Most of the hand, wrist, foot, and ankle elements are absent as well as both patellae. A small segment of the superior end of vertebral column is present and includes four cervical vertebrae and three thoracic vertebrae with most of their articular facets. Most of the 12 poorly preserved rib fragments were represented, showing post-mortem breakage, primarily due to insufficient ossification and fusing. No elements of the sternum or manubrium are present.

### Age, Sex, and Stature Assessment

Based on tooth eruption rates (Ubelaker 1989), the individual was approximately 8 years of age (± 24 months). This age determination is also consistent with diaphysis-epiphysis joining rates. A more accurate age could not be estimated. No gender or stature determination was possible due to the individual's subadult age.

### Pathologies

No obvious signs of pathologies were identified, although the friable and fragile nature of the elements made pathology identification of the limb and crania difficult. The dentition also demonstrates that this individual was healthy. The teeth demonstrated no hypoplasia lines or caries, sug-

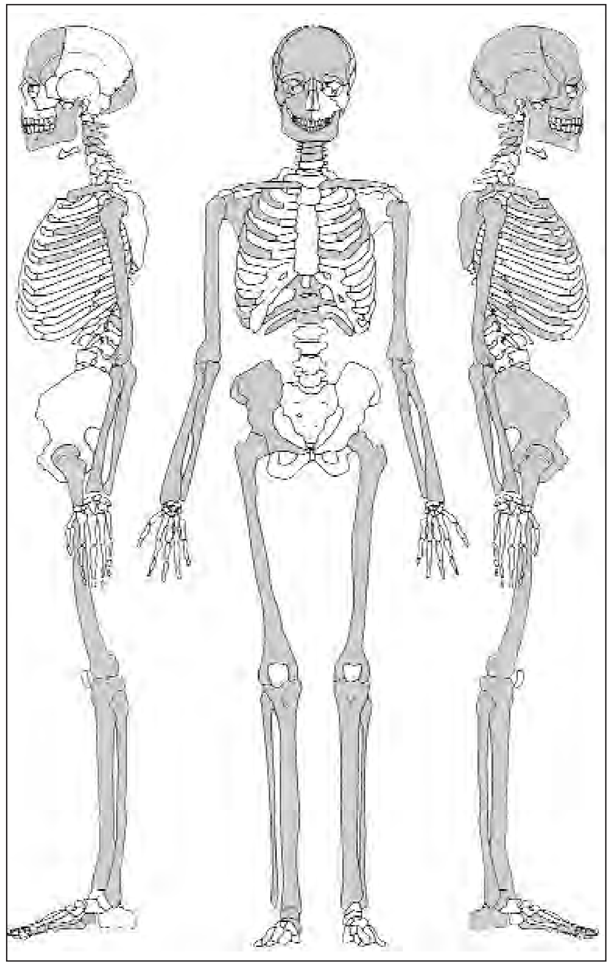

**Figure 29.2 Skeletal inventory for Feature 54.9.**

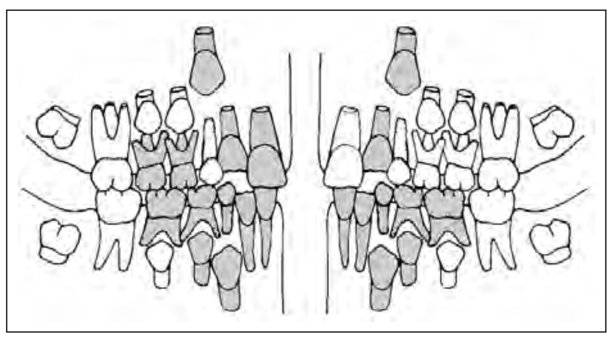

**Figure 29.3 Dental inventory for LA 6829, Feature 54.9.**



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gesting that this individual had not gone through any period of systemic disease or dietary stress.

### ***LA 6829, Feature 54.12***

Feature 54.12 is a primary inhumation in a flexed position probably resting on the back. The burial is nearly complete and is in a good state of preservation. This burial is an adult male between 34–42 years of age. He was about 5-feet 8-inches tall and suffered from no major pathologies.

The overall condition of the bone was good. Some elements, like phalanges, are absent. Rodent disturbance in and around the burial could account for the absence of these small elements. The cranium appears to have suffered the most damage. It is uncertain if this damage was post-depositional or perimortem.

#### Elements Present

Feature 54.12 is nearly complete with most of the missing elements related to the left hand (Figure 29.4). Most of the cranial bones are represented, although they are disarticulated and fragmentary. The occipital bone and some facial elements are absent. The occipital damage is consistent with back-resting burials. Several wormian bones are present, especially along the coronal and lambdoidal sutures. The mandible is complete and has a moderately angular chin. All of the teeth are present with the exception of a single upper incisor ($LI^1$) (Figure 29.5). All of the elements of both the arms and legs are represented, with the exception of most elements of the left hand and wrist, the left patella, and most of the elements past the ankle. All of the vertebrae and most of the pelvis (including sacrum) are present, although fragmented. Most ribs and the sternum are fragmentary, but present and show post-mortem fracturing.

#### Sex Assessment

Characteristics of the innominates (narrow sciatic notch, heart-shaped sub-pubic angle, and lack of pre-auricular sulcus) and those of the cranium (pronounced supraorbital ridges, retreating fore-head, developed external occipital protuberance,

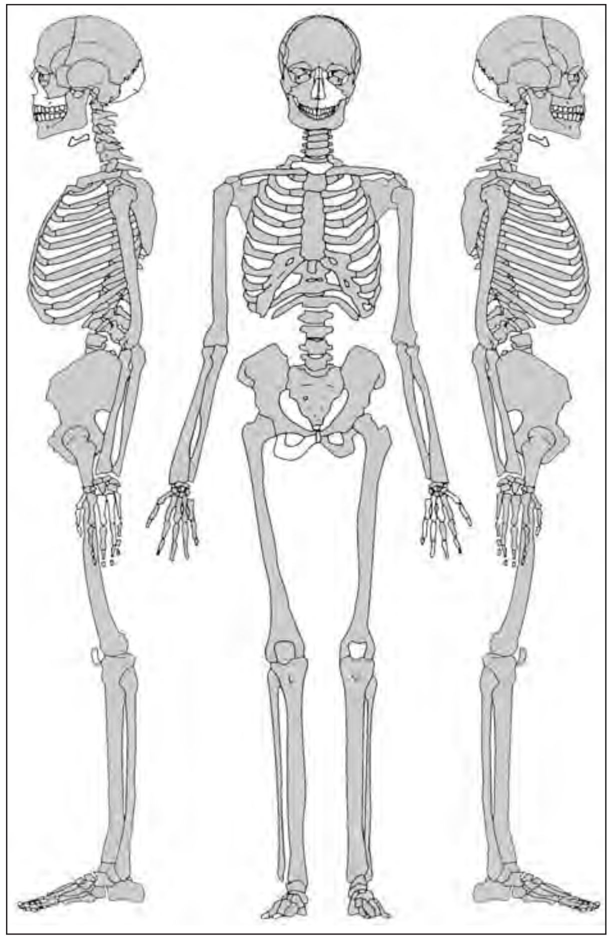

**Figure 29.4 Skeletal inventory for Feature 54.12.**

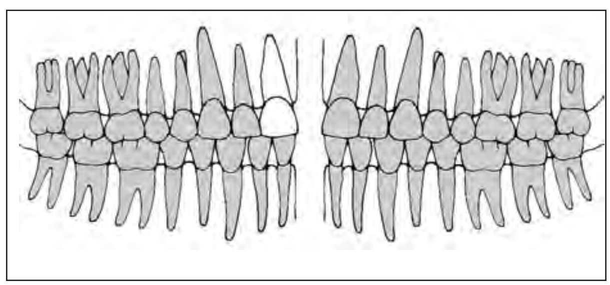

**Figure 29.5 Dental Inventory for Feature 54.12.**

square mental eminence and a gonial angle of close to 90 degrees) suggest that this individual is male. While less accurate, and more a function of sexual dimorphism, maximum femur and humerus lengths as well as midshaft circumferences also produced a sex determination well within the

range for adult male prehistoric Native American populations.

**Age Assessment**
All elements display fusion, including the medial portion of the clavicle. Most clavicles fuse between 23 and 30 years of age, with most fusing by age 28 (Krogman and Iscan 1986; Webb and Suchey 1985). Four methods of determining age specific pelvic changes were also utilized. By Todd's method (1920), both pubic symphyses are a VI, which relates to 30–35 years of age. Under the McKern and Stewart (1957) method, this individual is an I/2, II/3, III/1 for both sides, aging the individual between 18 and 37 years. Lastly the Suchey *et al.* method (1986) would classify this symphysis as an III for both sides, giving the individual a larger age range between 22 and 50 years of age. The Suchey *et al.* method gives a larger date range, because through their research they determined that the human variability in the pubis necessitated a larger age range than those estimated by Todd, McKern, and Stewart. The sternal end of the left and right fourth rib displays a tighter age range, between 34.4 and 42.3, a Phase 5 by the Iscan and Loth (1986) method (95 percent confidence interval).

More relative factors in determining age include the onset of age related pathologies (such as arthritis and osteoporosis). The vertebral column displayed light lipping of the lumbar vertebrae and the initial stages of degradation of the vertebral pad surface. The auricular surface of the pelvis shows light lipping and a slight remodeling of the surface. When all factors are taken into account, Feature 54.12 is safely estimated to be between 34 and 42 years of age at the time of death.

**Stature Assessment**
The stature of this individual is based on maximum length measurements for the femur, tibia, and humerus (Table 29.1). Based on the Trotter and Gleser method for white males, Feature 54.12 is estimated to be approximately 5-feet 9-inches tall (approximately 176 cm). This method tends to over estimate stature. Genovés method, based on Mesoamerican males and females, tends to underestimate stature. This method estimates that this individual is 5-feet 7-inches (approximately 171 cm). Given the limitations of each method, this individual was likely 5-feet 8-inches tall (approximately 174 cm).

**Table 29.1 Stature Estimate Metrics for Feature 54.12**

| Stature Based On | Maximum Length | Trotter and Gleser (1952) | | Genovés (1967) | |
|---|---|---|---|---|---|
| | cm | cm | ft | cm | ft |
| Femur | 46.8 | 172 | 5.64 | 169.65 | 5.57 |
| Tibia | 40.4 | 179.5 | 5.89 | 170.54 | 5.6 |
| Humerus | 34.5 | 176.5 | 5.79 | 172.18 | 5.65 |
| Average | | 176 | 5.77 | 170.79 | 5.61 |

**Pathologies Assessment**
Few pathological conditions were observed on the skeletal remains of Feature 54.12. The vertebral column shows only minimal lipping of the bodies and a beginning of degradation of the pad surface consistent with age and a life of manual labor. All other pathologies relate to the dentition. The dentition show mild occlusal wear. Four caries are present ranging from mild caries on the occlusal surface of the upper right first and the upper left third molars and the buccal side of left lower second molar. The left lower third molar has a large occlusal carie that extends through the dentin to the tooth root.

Mild to moderate dental hypoplasia is present on all upper and lower dentition with the exception of the lower incisors. The most extensive evidence is on the upper and lower canines, which have roughly four lines while the premolars have only one line. Developmentally, this would mean that this individual had dietary or system-wide stress at several times when those teeth were developing during childhood (roughly between two and 11 ± 2 years). The worst of these episodes happened around age three (± 1 year) given the number of lines and intensity of the cessation of enamel on the lower canines.

The wear stage and wear-plane angle was measured in accordance with the standards described by (Smith 1984), with respect to issues of diet and prehistoric food preparation. The individual of Burial 2 lies well within the range (wear stage 4, wear-plane angle +4) typical of agriculturists (Figure 29.6). Overall, this individual appears to have been in good health at the time of death, despite childhood illnesses. The cause of death could not be determined.

## ***Burials 1 and 2, Site LA 115260***

Burials 1 and 2 from site LA 115260 are a scatter of disarticulated human remains. The original burial positions and locations are unknown as the elements were scattered in a 4 x 8-m area within Feature 1, a midden. No elements were sufficiently complete to warrant metric data collection. The overall condition of the bone was good, although there is evidence present suggesting there had been damage due to surface exposure and post-depositional processes.

### Elements Present

Burials 1 and 2 from site LA 115260 include a scatter of miscellenous elements composing only partial skeletons. Two individuals could be positively identified by the presence of two right tali. Nearly all elements are represented, although these elements are fragmentary. From the crania, the temporal, parietal, maxilla, zygomatic, and the occipital bones are present. Other skeletal elements include scapula, metacarpals (1–5), hand phalanges (proximal, middle, and distal), navicular, lunate, thoracic vertebra, sacrum, ilium, tibia, femur, talus, metatarsal (third), foot phalanges (one middle and one distal), and indeterminate long bone fragments.

### Age, Gender, and Pathology Assessment

All elements display fusion, suggesting that these individuals are adults, although no estimates of gender or stature could be made. The auricular surfaces, especially on the tali and the one vertebral body, are not indicative of elderly individuals. No evidence of pathological conditions is present and the cause of death is unknown.

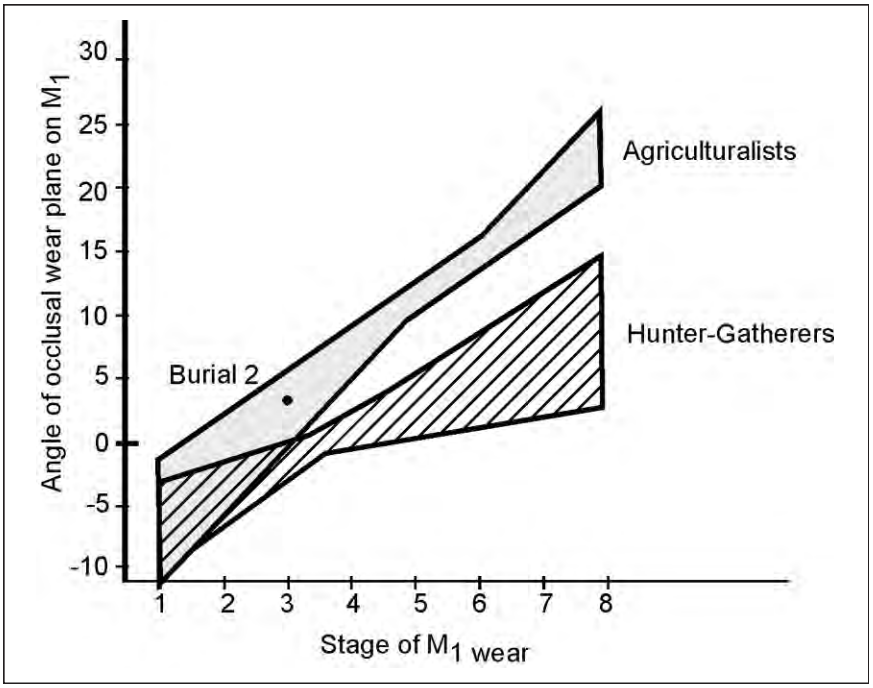


**Figure 29.6 Mandibular molar wear-plane index for hunter-gatherers and agriculturalists, showing location of individual from Feature 54.12 (adapted from Smith 1984).**

### *Burial 3, Site LA 115260*

Burial 3 from site LA 115260 is a scatter of disarticulated human remains. The original burial position and location is in unknown, although this individual had been cremated. No elements were sufficiently complete to warrant metric data collection.

**Elements Present**
Burial 3 from site LA 115260 is represented by two right, and one left temporal fragments, one juvenile molar crown (m1 or m2) with an undeveloped root, one unfused metatarsal, and one indeterminate cranial fragment.

**Age and Pathology Assessment**
The age of this individual, based on dental development, is birth–6 months (± 3 months). This dental-based age is consistent with the development of the other skeletal elements. No pathological conditions were evident and the cause of death is unknown.

### *Burial 4, Site LA 115260*

Burial 4 from site LA 115260 is a scatter of disarticulated human remains. The original burial position and location is an unknown, although this individual unlike Burial 3 had not been cremated. No elements were sufficiently complete to warrant metric data collection.

**Elements Present**
Burial 4 from site LA 115260 is represented by one right zygomatic fragment, one right ilium fragment, and one fragment of indeterminate long bone.

**Age and Pathology Assessment**
The age of this individual, based on skeletal size and development, is roughly birth–3 years. No pathological conditions were evident and the cause of death is unknown.

## Discussion and Interpretation

The following discussion and interpretations are based on data collected from a laboratory investigation. These data were compared to other osteological analyses of other and larger prehistoric populations. Only the two individuals from site LA 6829 are sufficiently complete to offer any insight into prehistoric occupation of this region, however, some general conclusions can be made.

### *Physical Comparisons*

Because of the highly fragmentary condition of human bones recovered from LA 115260, physical comparisons are possible for the burials unearthed at LA 6829, and principally the adult individual (Feature 54.12) from that site. This individual exhibits general stature and bone conditions characteristic of Native American populations. Similarly, all of the teeth recovered showed characteristic shoveling, which is only represented in high frequencies in Native American and Asian populations. No historic artifacts were recovered and the only artifacts present were made of chipped stone suggesting a prehistoric age. These physical characteristics and mortuary contexts leave no doubt that all the human remains recovered from these two sites are those of prehistoric Native Americans.

Although culture and "race" are topics rarely discussed in osteological terms due to the extreme variation within the human species, some general inferences can be made regarding the culture of origin of these individuals. Given that the burials are prehistoric in age and they were discovered in the American Southwest, some inferences can be made regarding culture. Some potential cultural candidates include people of the Archaic tradition, who practiced a hunting and gathering life way, Puebloan people who practiced agriculture, and the protohistoric Numic or Apachean who practiced a mixed subsistence strategy. Ways of life as influenced by diet is one of the largest factors that can be seen on the skeleton, mostly in the dentition.

Dental pathologies of the individuals of this collection are limited to normal occlusal wear and dental caries resulting from a grit-heavy diet. Hypoplasia seen with Feature 54.12 suggests systemic or nutritional stress in early childhood. The



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wear-plane index suggests that Feature 54.12 is well within the range of agriculturists. The possible cradleboarding present on this burial is suggestive of Puebloan populations.

Both of the intact burials at LA 6829 show demographic similarity to a collection of burials from the Henderson Site (Rocek and Speth 1986). The Henderson Site (LA 1549) is a late prehistoric, settled agricultural site located in the Pecos Valley near Roswell, New Mexico. The condition of the burials and general health of the individuals fit well into the population of individuals of the Henderson Site. In fact, Burials 25, 26 and 41 of the Henderson Site are nearly identical to Feature 54.12 of LA 6829. This individual was buried similarly, is of the same sex (male), stature, health, and condition as these three burials from the Henderson Site. It is important to note that the population of the Henderson Site is thought to be related more closely to western Texas populations than to other northern and western Puebloan populations (Rocek and Speth 1986). Similarly, the physical attributes of Feature 54.12 suggests an individual who was taller and more robust than average individuals of other northern Puebloan populations such as those buried at Salmon Ruins and Aztec Ruins.

### Comparisons with Regional Mortuary Patterns

Although the sample of human burials from the investigations is small, it is nonetheless worth considering their mortuary characteristics in a regional perspective. Prehistoric mortuary evidence from the Jornada Mogollon region comes from various investigations, the reporting of which varies considerably in quality. Table 29.2 presents a summary of mortuary data from a selection of reports in the Jornada Mogollon region. Although to an extent the range of variation in burial practices defies straightforward characterization, some recurrent patterns are evident.

Mortuary practices in the southern Jornada Mogollon region are difficult to characterize, given that cemetery populations have yet to be discovered, leading to the suspicion that formal cemeteries were not part of the cultural milieu here. Rather, it appears that subsurface burial was performed in an ad hoc manner, with burials located in a variety of contexts. One common pattern involves disposition of the corpses themselves, which are usually buried in a flexed position, although there is a range here from loosely to tightly flexed. Most graves contain a single individual only, although some multiple interments are known, with the notable exceptions being sites LA 5378 and LA 5380 in the Ruidoso area (on the northeast margin of the Jornada Mogollon area). Grave goods are rare, although the placing of ceramic vessels over the head of the deceased is not uncommon. This practice echoes similar mortuary customs in the Mimbres Mogollon area, and reflects the close interactional ties between the Mimbres and Jornada regions. This practice is also observed in the Sierra Blanca region to the north (Kelley 1984). In some cases, the vessel placed over the head is a Mimbres Black-on-white pot, although other vessel types are used in this context as well, ranging from apparently undecorated brownwares to late decorated wares such as Chupadero Black-on-white and Three Rivers Red-on-terracotta.

There is notable variation in terms of grave location, with burials found in pits beneath house floors, on house floor surfaces, in house pit fill, in extramural burial pits, and in trash middens. The burial of individuals beneath (or upon) house floors appears to become more common in the Doña Ana and, especially, El Paso phases, which correlates with the increasingly formal design and construction of dwellings during these periods. Still, extramural burials remain common throughout prehistory in the Jornada area. Even in Late Formative times, extramural burials are probably still more common than house-floor interments, but are less well documented because of the traditional investigation bias in favor of structures (see Miller 1990:67). Notably absent are formal cemeteries, which is not inconsistent with broader mortuary patterns in the Puebloan regions of the American Southwest.



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**Table 29.2 Mortuary Information from Selected Sites in the Central Jornada Mogollon Region**

| Site | Time Period | Burial Information | Reference |
|---|---|---|---|
| LA 845 | Early Mesilla phase | 1 adult burial, semi-flexed, several utilitarian items in association | Etchieson 1987 |
| Los Tules | Late Mesilla phase | 3 burials—2 flexed & 1 badly fragmented. 1 in pithouse fill, the other in a trash midden. 1 had pottery jar over skull | Lehmer 1948 |
| Roth | Late Mesilla phase | 5 burials, all adults | O'Laughlin 1981 |
| 41EP3022 | Late Mesilla phase | 1 burial w/ Mimbres Black-on-white vessel over skull. In circular pithouse | Clark 1994 |
| North Hills | Late Mesilla/Early Dona Ana phase | 4 burials, 3 adults & 1 child. Only one in a definite pit. Coble mounds placed over 3, including the child burial | Miller 1990 |
| Gobernador | Early Dona Ana phase | 1 adult burial, extramural context | Shafer *et al.* 1999 |
| Meyer | Late Dona Ana phase | 1adult burial, in Pithouse sub-floor pit. No grave goods | Peterson 2001 |
| Hueco Tanks | Late Dona Ana phase | 4 durials, all extramural. 2 associated w/ El Paso Polychrome vessels | Kegley 1982 |
| La Cabraña | El Paso phase | 1 sub-floor burial of child; oriented east, facing down; disturbance left only skull & upper torso | Foster *et al.* 1981 |
| Alamogordo | El Paso phase | 6 burials, all beneath room floors. All flexed w/ knees drawn up & arms folded across torso | Lehmer 1948 |
| McGregor Site | El Paso phase | 2 burials, both below room floors. 1 infant (poorly preserved) & 1 adult (semi-flexed) | Brook 1966 |
| Hot Well | El Paso phase | More than 25 burials, all in rooms, either in sub-floor pits or on top of floors. Both infants & adults | Brook 1970; Davis 1968 |
| Pickup Pueblo | El Paso phase | 1 adult burial, in sub-floor pit along west wall of room. No artifacts | Gerald 1988 |
| Condron Field | El Paso phase | 1 adult burial in pueblo room, on floor. Slightly flexed | Hammack 1964 |
| Public Service Board Well 44 | El Paso phase | 1 child burial in sub-floor pit of pueblo room. El Paso Polychrome vessel over the skull | Green 1968 |

Mortuary patterns in the Jornada Mogollon region hold potential implications in terms of settlement and sociopolitical patterns. Burial of the dead is typically a practice that is highly charged culturally, and thus subject to rules that vary between human cultures. Some researchers have noted cross-cultural regularities in burial patterns and their association with settlement, economic, and sociopolitical forms (e.g., Chapman 1981, 1995; Charles and Buikstra 1983), while others stress the culturally constituted nature of mortuary practice (e.g., Hodder 1982a, 1982b, 1991).

As noted by Miller (1990:68), "(t)he lack of uniformity among the locations and orientations of Jornada Mogollon burials may be a result of discontinuous habitation of these sites." Apparently, Jornada Mogollon peoples did not use mortuary sites to mark their territories or symbolize such claims, a practice otherwise common to many agriculturalists and intensive hunter-gatherer societies throughout the world (e.g., see Chapman 1981). This may be related to a long-term settlement trend that evolved a pattern of shifting sedentism during the Doña Ana and El Paso phases, in which sedentary villages were frequently relocated. It may also indicate that territorial claims were marked materially by other means—such as the multi-room dwellings themselves that appear in El Paso phase times, for instance. Even



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the graves themselves do not appear to have been marked visually in any enduring way for the potential benefit of living survivors. An unusual exception here are the cobble mounds and piles placed over graves at the North Hills I site (Miller 1990). Miller suggests that the possible intent of marking graves in this manner was to prevent their disturbance by subsequent occupations, which in turn might imply occupational continuity at this site (or at least anticipated continuity).

In terms of economic and sociopolitical dimensions, Jornada Mogollon burial practices are conspicuous by their lack of any clear indicators of social rank or inequality. No richly-furnished graves have been documented in the region, and the lack of grave goods, or at best very modest burial assemblages, suggests that whatever status differences may have existed in Formative-period societies in the area were not expressed in the mortuary realm. The pattern underscores the lack of indicators of formalized social inequality throughout the Jornada Mogollon sequence, and suggests that the organization of local societies here was predicated more on a communal mode of organization as opposed to a network mode (see Feinman *et al.* 2000). The communal mode, which de-emphasizes material expressions of hierarchical differences (even where such differences may indeed exist), is argued by Feinman *et al.* (2000) to have become the prevailing mode of sociopolitical organization during the Puebloan period in the American Southwest (i.e., the El Paso phase in the southern Jornada Mogollon region), following a more variegated mosaic of sociopolitical organization throughout the period during the preceding Pithouse period (i.e., the Mesilla Phase in the southern Jornada Mogollon; the Doña Ana phase being transitional between the two). In this sense, the El Paso phase appears consistent with broader patterns observed throughout most of the Puebloan Southwest, with mortuary patterns being one of many indicators of unstable, dynamic societies operating in the extremely marginal, desert environment of the region.

The two graves from LA 6829 are consistent with general mortuary patterns and variability observed in the Jornada Mogollon regions. Both burials are flexed, one placed in a pit and the other directly onto the interior floor of a structure. Burial goods are absent, or at best modest, if the small amount of goods in proximity to these burials are, in fact, grave offerings. This is also consistent with regional patterns. The scattered remains at LA 115260 apparently represent individuals buried, in an ad hoc manner, within the midden area on the site.

## Summary

Remains of at least five individuals were recovered during the investigations, two from LA 6829 and three from LA 115260. The individuals from LA 6829 were both documented *in situ*, while those from LA 115260 were fragmentary and scattered, and recovered during screening. The five individuals include one juvenile, eight years of age, with possible cradleboarding; one adult male 34–42 years of age; two adult individuals; and one cremated infant aged 0–6 months. All five individuals appear to be representative of Puebloan populations with a diet based on an agricultural economy. The health, stature, and burial conditions are well within the range of the variability described for the Henderson Site population in the Pecos Valley. The metric similarity of the individuals of this collection, like those of the Henderson Site, are possibly related more closely to populations from western Texas and not northern Puebloan populations. In terms of mortuary patterns, the burials from LA 6829 fall within the range of variability found in the Jornada Mogollon region; both are flexed, one is in a pit while the other is on a house floor, and neither contains burial offerings indicative of social status or inequality.



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Chapter 30

# PIT FEATURES

*Jim A. Railey, Richard M. Reycraft,*
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Pits are typically the most ubiquitous feature type found at preindustrial archaeological sites. In terms of function, pits were used for cooking, processing, storage, heating, human or animal burial, and water catchment. Although the project uncovered human burial pits and possible water catchment facilities, these feature types are dealt with elsewhere in the report (specifically, Chapters 6 and 29) and are not covered here. This chapter focuses primarily on thermal features and the (less frequent) non-thermal pits.

In many cases, the use for which a pit was originally dug may not be at all self-evident, from either its morphology or contents. Because pits make convenient loci for trash disposal following the end of their use life, most or all of their archaeological contents may not relate to the pit's original function. For this reason, archaeologists often refer to "trash pits," although it is maintained here that prehistoric peoples rarely, if ever, dug pits expressly for the disposal of trash. Accordingly, the term "trash pit" is not used in this discussion (even though the contents of the US 54 pits often consisted of secondary trash). Other archaeological traces, such as oxidized surfaces, thermally altered rock or caliche, or spontaneously combusted, stored plant remains provide more direct clues as to a given pit's likely function.

In recent years, archaeologists have devoted greater effort in an attempt to understand the potential function of pit features. Part of this effort has involved attempts to classify pits according to behaviorally meaningful criteria. Given the diversity of pit sizes and morphology, however, and continuing uncertainty surrounding the functions of most pits, little standardization has been achieved in the classification of pit features. Because pits are often an interpretive challenge, attempts to understand them have made extensive use of ethnohistoric, ethnographic, and experimental research. Use of these sources has greatly enhanced efforts to interpret and explain the meaning and significance of pits uncovered in archaeological contexts.

## Pit Categories

Pits investigated during the US 54 project were divided into two categories: thermal and non-thermal. The discriminating criteria had little to do with pit size and morphology; rather, inclusion in one or the other category hinged on the presence or absence of thermal materials—specifically, ash staining, charcoal, and/or thermally altered rock or caliche. In the absence of oxidized surfaces or other *in situ* indicators of thermal activity, such as a dense, discrete layer of thermally altered rock or caliche, this definitional criterion is potentially problematic, as any of these thermal materials could have been dumped into a non-thermal pit following its disuse. As a result, it is likely that some features that did not serve a thermal function were classified as thermal features, as a result of their secondary contents. It is also conceivable, though unlikely, that a thermal pit could have been completely cleaned out, to the extent that any ash, charcoal, and thermally altered rock were removed, after which the pit was filled with non-thermal debris. In such an instance, the pit would not be recognized archaeologically as a thermal feature and would likely be placed in a non-thermal category. Despite these caveats, it is assumed here that the distinction between thermal and non-thermal pits, based on the presence or absence of thermally altered debris or residues, is an accurate reflection of pit function in the vast majority of cases.



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## Thermal Features

Most of the pits uncovered at the US 54 sites were identified as thermal features. As stated in the site description chapters, a somewhat arbitrary distinction was made between small and large thermal features. Small thermal features are defined as those with maximum diameters of less than 70 cm, while large thermal features include those with diameters of 70 cm or more. Pit depth was not considered a critical variable in pit designation because erosion and surface stripping of site overburden have likely removed up to several decimeters from the upper portions of most pits, and has completely obliterated others, leaving either no traces or completely deflated concentrations and scatters of thermally altered rock and caliche. It should be noted, however, that erosion has probably also reduced the original diameter of many thermal pits, especially those with low-angle walls. Thus, it is suspected that the number of small thermal pits identified in the US 54 project has been inflated somewhat by the side effects of erosion and surface deflation.

In general, it was assumed that small thermal features represent hearths, while their larger counterparts are the remains of roasting pits. Although there is no clear standardization in the use of the terms hearth and roasting pit, for this project the following definitions are employed. Hearths are thermal features used for space heating, heating of rocks for stone boiling or placement in an earth oven, and/or any cooking technique that does not involve covering with earth. Hearth cooking includes incidental roasting of skewered foods directly over a fire, or longer-term grilling, smoking, or drying of food placed either directly on a flame or open bed of coals, or on an elevated rack or spit. The key attribute of a hearth is that it is not covered with earth and the fire or hot coals are allowed to burn in a largely oxidizing atmosphere. The degree of oxidization may vary within the hearth, especially in one involving a thick pile of coals, within which oxidation would be progressively reduced toward the base of the pit. As a result, hearths tend to produce large quantities of ash and comparatively little charcoal (see Doleman 1997:164). Note that hearths may include non-pit features; the most informal hearths are those in which a fire is built directly on an unprepared surface, and in the American Southwest these simplest of hearths were apparently the most common type of thermal feature prior to the Middle Archaic.

Roasting pits are earth ovens (also referred to as pit ovens or Dutch ovens) designed specifically for slow, long-term cooking. The food is wrapped and placed in a pit, along with heating elements (heated rocks and/or hot coals) and then covered with earth. In one roasting pit experiment, for example, Doleman (1997) cooked a turkey and some vegetables that were insulated in burlap and a bed of wet maize husks. When hot coals are used for the heating element (frequently in conjunction with heated rocks), the reducing atmosphere maintained within a covered roasting pit results in significantly more charcoal and less ash than are produced in an open hearth (Doleman 1997:164). Upon completion of a cooking episode, roasting pits must be opened to remove the prepared food, thus disrupting and potentially removing the heating elements and charcoal, or at least those thermal materials covering the food. Roasting pits are often intended as repeatedly-used facilities because they are typically larger than hearths and require a greater energy investment to dig in the first place. To facilitate re-use, roasting pits are frequently cleaned out. Doleman (1997) found that his experimental roasting pit produced abundant charcoal and FCR debris that needed to be cleaned out before the pit oven could be used again. Cleaned-out thermal materials are usually dumped on the surface next to the pit oven, and even after repeated, thorough cleanings, at least some of the removed charcoal and FCR may find its way back into the pit as “secondary” fill.

Although the functions of thermal pits certainly cannot be discriminated only on the basis of an arbitrary size criterion, cross-cultural and experimental studies do suggest that roasting pits tend to be larger than hearths (Bell and Castetter 1941;



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Castetter *et al.* 1938; Cushing 1920; Dering 1999; Doleman 1997; Wandsnider 1997). These studies uniformly suggest that roasting pits are large features with recorded dimensions that varied from slightly less than a meter to several meters in length, and 50 cm–1 m in depth. Based on this evidence, the 70-cm threshold, used here to discriminate between small and large thermal features, is probably also a reasonable (but by no means rigid) measure for differentiating hearths from roasting pits. Doleman's (1997) successful thermal pit experiment supports this size threshold; specifically, his hearth (used for heating rocks used in stone boiling) measured 65 cm in diameter, while his roasting pit was 85 cm in diameter. Differences in Doleman's pit depths were less variable, with his hearth being 25-cm deep and his roasting pit only 5 cm deeper, and so his findings also support the exclusion of thermal pit depth as a size-classification criterion.

### *Thermally Altered Rock*

Ethnographic accounts (e.g., Binford 1983; Hester 1991; House and Smith 1975; Thoms 1989) and experimental studies (e.g., Doleman 1997) have also provided information concerning characteristics of thermally altered rock (TAR) used in hearths and roasting pits. As noted by Jennis *et al.* (1997:2), "(r)ocks were used prehistorically in fire because of their ability to contain, absorb, retain, and transfer heat for bathing, warmth, and cooking." In the prehistoric Jornada region, the procurement of suitable rock for TAR was sometimes difficult in the interior basin locations, and caliche was often substituted as a heating element in pit cooking. For this discussion, then, the term TAR includes both thermally altered rock and caliche.

Experimental studies have found that different types of rock have significantly different thermal properties, and some types are better suited for thermal tasks than others. Doleman's (1997) thermal pit experiment is especially relevant to the US 54 project, because it was geographically close and involved archaeological and experimental TAR that included a range of rock types somewhat similar to those available in and around the Tularosa Basin. Specifically, Doleman found that basalt and other mafic igneous types (i.e., diorite and gabbro) were the most durable; that is, they held up longer to repeated thermal stress before fracturing into small, unusable fragments. Limestone, granite, rhyolite (both vesicular and non-vesicular), and siliceous rocks were less durable. Quartzite was the least durable of the rocks used in his experiment. Doleman also found that stone boiling, with its rapid-cooling effects, induces considerably greater stress upon heated rocks than does pit roasting, resulting in higher fracture rates and more angular fractures. The durability of basalt makes it preferable to the other materials for stone boiling and its high heat retention also made it highly suitable for pit roasting. The lower thermal stress conditions in pit oven cooking means that other, less durable types of stone might also be used for this task, especially if combined with hot coals. Basalt was not identified in the US 54 assemblages and, as explicated later in this chapter, granitic rocks were apparently the preferred TAR material within the project area.

Changes in cooking technologies over time probably also affected the manner and frequency with which TAR was employed in the Jornada Mogollon region. Specifically, the introduction of ceramics at ca. A.D. 200 probably led to a sharp reduction in the use of stone boiling; preparing food in ceramic containers obviates the need to pre-heat stones to achieve boiling or simmering of the liquid contents and is considerably less laborious. Thus, the frequency of TAR use probably diminished considerably during the Formative period relative to the preceding Late Archaic. To the extent that this is true, we might also expect to find fewer hearths in relation to roasting pits during the Formative, as Late Archaic cooking practices probably involved more small thermal pits for heating rocks used in stone boiling. Note, however, that pit roasting often also involves heating of rocks in a separate hearth before placing into the earth oven. At any rate, pit roasting



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remained a mainstay of cooking technology during Formative times, resulting in continued use of TAR.

## ***Hearths, Roasting Pits, and Site Function***

Along with temporal variation, site function can also affect the frequencies and ratios of hearths versus roasting pits. Specifically, we should probably expect ephemeral, short-term sites used as hunting camps or transient stopovers not to contain roasting pits, and perhaps not even archaeologically detectable hearths, although preserved hearth features may be present, especially in campsites that were intended to be used repeatedly. Roasting pits should be present at sites used for logistical acquisition and processing of specific food resources (such as agave). At such sites, roasting pits may outnumber hearths. Some ethnographic and ethnoarchaeological studies (e.g., Binford 1983; O'Connell 1987; Yellen 1977) indicate that "large, communal cooking activities involving earth ovens and roasting pits take place away from the main camp" (Jennis *et al.* 1997:3). This probably does not mean, however, that we should always expect an absence of roasting pits at longer-term residential sites. Such sites typically contain numerous hearths, but they may also contain roasting pits, depending upon the types of foods cooked on a regular basis, the food acquisition logistics involved, and the extent to which individual families regularly cooked food in earth ovens.

## ***Roasting Pits—Types and Techniques***

Four different categories of roasting pits have been identified in the Jornada Mogollon area. Type A is a simple thermal pit that lacks TAR; Type B is lined, or partially lined, with TAR; Type C has TAR fill, and Type D represents surface concentrations of TAR. Some of these differences may have resulted from different cooking practices, while others (especially TAR concentrations) relate to site formation processes. Type A pits may have been employed in meat cooking, and this function may be inferred from rock-free roasting pits. Alternatively, any TAR once present may have been removed for reuse or disposal. Type B almost certainly represents the *in situ* remains of TAR in a roasting pit. Ethnographic and cross-cultural evidence indicates that many roasting pits had TAR-lined bases, and sometimes additional layers of TAR were interspersed throughout layers of food to maintain an even, high heat level (Bell and Castetter 1941; Castetter *et al.* 1938; Wandsnider 1997). The TAR fill found in Type C pits may represent re-deposited heating stones, which were originally stratified between food layers. Removal of the food after cooking would have disrupted the TAR layers. Type D pits represent either the deflated remains of Type B and C pits, or TAR discarded from roasting pits.

Information provided by Wandsnider (1997) suggests that large, deep, hot-rock roasting pits were used primarily for cooking fructan-bearing, inulin-rich plants. In the greater southwest, such species include agave crowns, yucca stems, cholla buds, mesquite bean pods, and sweet corn (Bell and Castetter 1941; Castetter *et al.* 1938; Wandsnider 1997; Ward 1980). Pit cooking inulin-rich plants over long periods of time depolymerizes the inulin, which increases the amount of available fructose and glucose residues (Wandsnider 1997). The result is a sweet tasting, energy-rich product.

Replicative studies (Dering 1999) and ethnographic accounts (e.g., Bell and Castetter 1941; Castetter *et al.* 1938) attest to the abundant labor and time required for pit roasting such plants. One way to reduce high per capita labor requirements is communal roasting, whereby multiple individuals share labor costs by cooking large quantities of these plants in very large pits. Communal roasts of wild species occur when the plants are ripe, and in the case of agave, beginning to flower (Castetter *et al.* 1938). Maize roasting in large pits often occurs during the growing season when the corn is still green, or after harvest when unripened husks remain on their stalks (Ward 1980). Green corn kernels are composed of sugars, and pit roasting destabilizes



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the enzymatic reactions necessary for the conversion of sugar to starch, thereby ensuring a sweet corn by-product with a long shelf life (Wandsnider 1997).

Sweet taste and a long shelf life are characteristics consistently emphasized in ethnographic accounts of pit-roasted, inulin-rich foods (Bell and Castetter 1941; Castetter *et al.* 1938). Based on extremely low return rates for pit roasted agave and sotol, Dering (1999) has posited that such species were low-ranked resources utilized primarily during periods of repeated stress. Dering's (1999) study provides specific caloric yields that indicate agave and sotol do rank very low as dietary staples. His diet-breadth approach, however, fails to consider the effects of economies of scope and scale, the benefits of long-term storage, and the potential use of such resources as delicacies.

The diet-breadth model is based on assumptions of optimal resource procurement. In short, optimality assumes that, within a specific feeding location or patch, higher-ranked resources will be targeted at the expense of lower-ranked ones (Krebs and Davies 1986). Resource ranking is based on caloric yields after procurement and processing costs, and "(a)s foragers encounter high-ranked resources, low-ranked resources are dropped from the diet even if low-ranked resources are abundantly available in the area." (Dering 1999:667). As environments change, resource distributions will shift, and differently ranked resources will be utilized. From this argument, Dering concludes: "the utilization of low-ranked resources implies that high-ranked resources were not encountered" (Dering 1999: 667). This implication led Dering (1999) to propose that pit-processed agave and sotol were primarily starvation foods.

Although many of Dering's (1999) conclusions may be correct, his use of the diet-breadth model fails to consider the advantages of economies of scope and economies of scale. Economies of scope consider the advantages of joint production under shared management (Pindyck and Rubinfeld 1989). For example, if two resources, one higher-ranked and the other lower-ranked, are available in a given patch, and both can be processed without scheduling and manpower conflicts, then joint production may be advantageous by providing greater economic yield than the selective processing of the higher-ranked resource alone. Prehistoric Southwestern agriculture provides a good example of an economy of scope. Although the greatest yields may come from maize, most agricultural peoples supplemented maize with beans and squash. These three cultigens often shared the same agricultural plot, but the production of beans and squash did not detract from the yield of maize. In a purely foraging situation an economy of scope might occur if the lower-ranked resource was accessible during an interim that did not detract from the processing of a higher ranked resource. As the pit processing of inulin-rich plants occurs over a very short interval, often just a few days during the spring and/or summer flowering seasons, it may not have affected the processing of higher ranked resources such as cultigens or piñon nuts, which would not be fully ripe until the fall. Economies of scope must also consider personnel. If high-ranked resources are primarily procured by a particular category of individuals, say young adult males, then other individuals in the group will be free to process lower-ranked resources.

Economies of scale happen when output increases occur in proportions greater than the concomitant labor input. This situation occurs where the initial investment in facilities is recouped through reuse, and where increasing marginal returns for labor occur in production. In the case of pit processing, communal pit construction and firewood gathering could conceivably lower per capita input costs, significantly increasing caloric yield. This non-proportional increase in output could be significantly enhanced if these pit features were reused across seasons, and ethnographic evidence suggests that many pit features were reused (Castetter *et al.* 1938:28).



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Dering's (1999) diet-breadth model also fails to consider the roles of risk and uncertainty in resource procurement. Risk, or the probability of a future loss of resources, is a highly variable, relatively stochastic phenomenon in the American Southwest. The region's marginal environment, which lacks inter-annual continuity in rainfall, exacerbates conditions of risk. High risk causes uncertainty, or the inability to make an informed decision on a future state (Alden-Smith and Boyd 1990). Because of risk and uncertainty factors, individuals in the greater Southwest often adopted risk-minimization strategies that entail the processing of lower-ranked resources as backups for long-term storage. Pit processing of inulin-rich plants, which destabilizes enzymatic reactions, results in an end product with a long shelf life (Wandsnider 1997). Ethnographic accounts of mescal, the end product of agave pit processing, repeatedly emphasize its capacity for long-term storage (Bell and Castetter 1941; Castetter *et al.* 1938), while the end products of other pit-processed, inulin-rich plants remain edible 36–60 years after processing (Wandsnider 1997).

Finally, diet-breadth models are constructed to assess the quality of dietary staples. Such models cannot, however, help us understand the use of delicacies. Delicacies are, by their very nature, high cost, low yield products. The high social value placed on a delicacy stems from the unique way that it stimulates the palette, usually through a rich or sweet taste, along with its rare or costly nature. Delicacies are luxury items, which in classless societies are produced through high labor investments. Ethnographic accounts of pit-processed, fructan-bearing, and inulin-rich plants typically emphasize the sweetness of the resulting byproduct (Bell and Castetter 1941; Castetter *et al.* 1938; Wandsnider 1997). Large portions of mescal were often eaten immediately after pit processing, with the remainder prepared for storage (Castetter *et al.* 1938). Sweet foods were extremely rare in the prehistoric Southwest, and a high value was placed on mescal because of its taste. The product was also produced for trade, had ritual significance, and was carried on war expeditions (Castetter *et al.* 1938). The ritual and warfare use of mescal is likely a result of the effects of fructan, which is a rapidly tapped source of energy (Wandsnider 1997). The resulting energy bursts would be considered useful in both circumstances. Portability, an additional quality of mescal, would also prove useful in trade and warfare.

The ethnographic evidence suggests that relatively large roasting pits with hot rocks were primarily utilized for the processing of inulin-rich plant species. Prehistoric peoples who integrated inulin plant processing into a compatible resource procurement system, thereby implementing economies of scope, likely increased their overall yields. The high processing costs of pit-roasting these plants could have been decreased by communal processing, which enabled economies of scale, and by harvesting agave, sotol, and like species during the early stages of flowering, when the plant contains the maximum amount of utilizable energy (Wandsnider 1997). The resulting byproducts, although poor resource staples, were excellent delicacies with long shelf lives. Their utility as long-term stores would have ensured that they were processed wherever and whenever possible. Their use in ritual, warfare, and trade would have enhanced their value.

Other types of roasting pits were employed for meat processing. High temperature cooking coagulates muscle protein as a result of water loss, resulting in a tough-textured food (Wandsnider 1997). To avoid this, lean meats can either be cooked with a brief exposure to moderate heat or longer exposure to moderate moist heat. On the other hand, more fatty and collagen-rich meats benefit from longer exposure to moist heat, which converts collagen to gelatin and preserves lipids for recovery. An ethnographic survey by Wandsnider (1997) determined that lean meats tend to be either spit roasted or boiled, while fatty meats are either pit roasted or roasted over a bed of ash/coals. In non-riparian areas of the Jornada Mogollon, lipid-rich meat sources would have



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been rare. These include the heads of deer and pronghorn and portions of the mountain sheep, the latter of which would likely have been present in the Jarilla Mountains and highlands that surround the Tularosa Basin (O'Laughlin and Gerald 1977). The fatty portions of these animals also tend to be processed in bulk, which would have required larger roasting pits.

According to Wandsnider (1997), lean meats are seldom pit roasted because they are more suitable for spit roasting or boiling. However, the Surprise Valley Paiute did pit roast rabbits (Kelly 1964), which are considered lean. Lean animals may put on fat seasonally, and pit processing promotes fat retention and thus meat tenderization. In the Jornada Mogollon and other locations where fatty foods are rare, rabbits and other lean animals may have been at least seasonally pit roasted to preserve their fat content. Because of their size, rabbits may also have been processed in smaller pits. Thus, many of the small thermal pits (i.e., those < 70 cm in maximum diameter) uncovered in the US 54 project may have been rabbit-roasting pits, rather than hearths. Finally, as protein requires only limited exposure to moderate heat to enhance its nutrient value, and because fat dispersion contributes to rapid heat transfer, most ethnographic examples of pit-processed meats did not employ TAR, relying upon charcoal and the less efficient thermal qualities of the pit sediments themselves to cook the meat. Experimental studies, however, have successfully pit-cooked meat in earth ovens with TAR (e.g., Doleman 1997). In summary, both fatty and lean meat may have been pit processed with or without TAR. Fatty meats typically required larger pits, while lean meats (such as rabbits) could usually be cooked in smaller ones.

## Non-thermal Pits

Based on ethnographic evidence, non-thermal pits include as least six functional types: storage, processing, support features, wells, borrow pits, and graves (Hackbarth 1993; Wöcherl 1998:249). Based on evidence from the US 54 project, water catchment and storage facilities (or *huecos*, which are similar to dirt tanks, as opposed to true wells) represent another type of non-thermal pit. Graves and water catchment pits are dealt with elsewhere in this report, and are excluded from this discussion. Non-thermal pits from the US 54 project are much fewer in number than thermal pits, and potentially include storage and non-thermal processing facilities.

Storage pits range from small, shallow bins often found beneath structure floors, to large, deep, underground silos that are usually cylindrical or bell shaped. The latter types of features were typically used for long-term storage of grain. Through the use of proper drainage and lining (such as mold-resistant vegetation), grains can be stored for many months in deep, underground pits. In the prehistoric American Southwest, straight-sided (i.e., cylindrical) pits are the most common, although bell-shaped forms also occur (Fritz 1974; Hackbarth 1993; Howard 1988; Huckell and Huckell 1984:12). Bell-shaped pits, in fact, appear to be quite common at large Mesilla-phase sites in the central Jornada Mogollon (see Whalen 1994b).

Storage pits are widely recognized as important indicators of residential commitment and logistical planning, although as potential indicators of seasonality of occupation and settlement mobility, their implications are debatable. DeBoer (1988), for example, argues that subterranean storage pits are indicators of planned winter abandonment of settlements where such pits occur. The rationale here is that subterranean storage implies concealment to prevent discovery and plunder by one's enemies during the period of winter absence. Although this scenario may indeed be relevant to many cross-cultural contexts, Railey (1999:460–464) contends that the argument does not always hold, noting the presence of large, bell-shaped storage pits in ancient China in settlements that were obviously occupied year-round, including walled towns associated with fully sedentary, state-level societies. With respect to early pithouse settlements in the Southwest, Wills (1991:172–173) even seems to



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go the opposite route taken by DeBoer. At the Shabik'eschee site, Wills suggests that stone-lined cysts, whose upper portions are above ground and in public view, indicate planned, long-term abandonment with an intention to return, whereas the larger, subterranean storage pits at the SU site, most of which occurred inside pithouses, indicated to Wills more constant access rather than a caching tactic.

Smaller storage pits and bins may be difficult to identify as such. A diverse variety of items were stored and cached underground prehistorically, and involved a similarly wide range of pit sizes, shapes, and depths. Pits used for storing materials other than large amounts of grains can thus be difficult to interpret correctly, and assigning specific storage functions to these features can be problematic.

In the central Jornada region, storage pits are documented beginning with the Mesilla phase. Lehmer (1948:26) excavated four pits at the Los Tules site, a large late Mesilla site near Las Cruces (see Chapter 3). One of these was cylindrical and inside a structure, while the other three were bell-shaped and extramural. At Turquoise Ridge (Whalen 1994b), 14 storage pits were uncovered, and most of these were bell-shaped. Eleven of these were located within structures, while the other three were extramural. Storage pits are rare to absent at other Mesilla-phase sites, and their frequency at Turquoise Ridge is consistent with other evidence from this site indicating its residential function. At smaller, seasonal Mesilla-phase sites, such as Huesito (Whalen 1981b), storage pits are generally not found. At the late Mesilla/early Doña Ana-phase site at the North Hills Subdivision (Miller 1990), only one storage pit was identified, and it was located inside one of the several non-formal pit structures excavated at this site.

Large storage pits are not well documented for the Doña Ana phase. Graves and Daras (2001:122–123) observed that extramural storage pits from this phase on average tend to be slightly larger in surface area and include more oval plan shapes than those of the Mesilla phase, which generally has smaller, circular storage pits. Doña Ana-phase storage pits also tend to be slightly shallower than those from the Mesilla phase and are commonly basin-shaped, although both cylindrical and bell forms are also present. At the early Doña Ana Gobernador site (Miller 1989; Shafer *et al*. 1999), only one storage pit was positively identified as such, while two additional pits were also suspected to have been storage facilities. Excavations at the nearby Ojasen site did not uncover any storage pits. At Meyer Pithouse Village, a late Doña Ana-phase site, extensive excavations uncovered nine possible storage pits inside of structures (although most of these were not large, deep pits), and three definite storage pits and three possible ones were identified in extramural contexts (Graves and Daras 2001). At Hueco Tanks no storage pits were identified, although the excavations at this site focused on structures and did not expose large portions of extramural areas (Kegley 1980).

Similarly, most excavations at El Paso-phase sites have focused on architecture only. A notable exception is the late El Paso-phase Firecracker Pueblo (O'Laughlin 2001a), where excavations exposed a large extramural area around a linear room block. Along with the surprising number of pithouses (see Chapter 3), these excavations also uncovered 47 probable storage pits, all cylindrical forms, excavated into the caliche substrate. Like most pueblos elsewhere in the southwest, El Paso-phase room blocks typically contain small rooms that were probably also used for storage.

Non-thermal processing pits include leaching or soaking basins, mortars for pulverizing dried grain or other materials, pits for mixing and preparing adobe, and other potential functions. Inferring these types of functions among archaeologically excavated pits is usually very problematic.

## US 54 Pit Features

The excavated US 54 pit features, along with size data and other statistics, are described in the respective data recovery site chapters (Chapters 6–16). These data are not repeated here; rather, this section presents a summary of the relevant data, inter-site comparisons, and a discussion of the implications for site function, settlement patterns, and diachronic changes within the project area.

### *US 54 Thermal Pits*

Thermal pits were, by far, the most numerous feature type identified in the US 54 project. Thermal pits were divided into small and large categories, with the assumption that most of the smaller thermal pits were hearths while their larger counterparts were roasting pits. Earlier in this chapter, it was suggested that we might expect the ratio of hearths to roasting pits to decrease from the Late Archaic to the Formative periods, given the likely evanescence of hot-rock boiling following the appearance of ceramic containers at the beginning of the latter period. It was also suggested that the ratio of hearths to roasting pits might be indicative of site function. Accordingly, the first measure examined here involves ratios of small to large thermal pits (Table 30.1).

As seen in Table 30.1, almost all of the sites have more small than large thermal features, regardless of temporal affiliation. The two sites with the largest numbers of thermal features, Jaca (LA 6829) and Orogrande 1 (LA 128699), contained the next highest ratios of small to large thermal features among the sites containing more than one such feature. At Jaca, a large late Doña Ana/early El Paso phase residential site, small thermal features outnumber large ones almost five to one. Orogrande 1, a predominately Late Archaic site with a smaller Mesilla phase component, produced the largest number of thermal features, and here small thermal features outnumber large ones almost three to one. Numbers of excavated features (including thermal ones) were much lower at the other sites, and at those with more than four thermal features, in all but one case the majority were small. The ratio of small to large thermal features at LA 115262 (a Late Archaic and Mesilla site) is 1.7:1, at LA 126181 (a Formative-period site) the ratio is 1.2:1, and at Orogrande 2 (LA 128700) the ratio is almost even (1.1:1). At LA 115260 and LA 115265, two Doña Ana-phase sites that may be part of the same community, similar numbers of large and small thermal features were excavated at each, although the sample sizes are extremely small, and the derived ratios are not statistically significant.

**Table 30.1 Numbers of Excavated Small and Large Thermal Pits at the Data Recovery Sites**

| Site | Small | Large | Small:Large Ratio | Temporal Components |
|---|---|---|---|---|
| LA 6829 | 58 | 13 | 4.5:1 | Formative (Doña Ana/El Paso) |
| LA 115256 | 1 | 1 | 1:1 | Formative (Mesilla) |
| LA 115259 | 0 | 1 | 0:1 | Formative (Mesilla) |
| LA 115260 | 2 | 2 | 1:1 | Formative (Doña Ana) |
| LA 115262 | 19 | 11 | 1.7:1 | Late Archaic (Hueco) and Formative (Mesilla) |
| LA 115263 | 1 | 0 | 1:0 | Unknown |
| LA 115265 | 2 | 1 | 2:1 | Formative (Doña Ana) |
| LA 126181 | 11 | 9 | 1.2:1 | Formative (Mesilla and Doña Ana) |
| LA 128699 | 61 | 23 | 2.7:1 | Primarily Late Archaic (Fresnal); smaller Formative (Mesilla) |
| LA 128700 | 13 | 12# | 1.1:1 | Formative (Doña Ana) |
| LA 128708 | 3* | 8 | 1:2.7 | Late Archaic (Hueco) and Formative (Mesilla) |

*Excludes four small thermal features that were historic in age.

# Includes two deflated features with assocated FCR scatter.



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Orogrande North (LA 128708), containing Late Archaic and Early Formative components, is the only US 54 site with more than one thermal feature where large thermal features outnumber small ones. Here, prehistoric large thermal features outnumbered their smaller counterparts almost three to one, although the sample size is small (only 11 prehistoric thermal features were excavated at this site). Still, surface evidence (mostly from outside the intensively investigated right-of-way) revealed numerous large, deflated thermal features suggesting many roasting pits were dug and used at this site.

In terms of temporal trends, it is clear from the ratios of small to large thermal pits that there is no evident change from the Late Archaic to Formative-period occupations represented in the US 54 sites. The data fail to support the suggestion that there might be proportionately fewer hearths than roasting pits in Formative components, as opposed to Late Archaic ones, due to the evanescence of stone boiling. Of course, these numbers could be somewhat misleading in terms of trends in pit function, as some of the small thermal features may have served as pit ovens. Moreover, hearths served a variety of functions, and continued in use during Formative times, no doubt, even if stone boiling was no longer practiced. But at any rate, the evidence does not support any reduction in the relative frequency of hearths from the Late Archaic to Formative periods.

As suggested above, ratios of hearths and roasting pits may still relate to differences in site function, although exactly how remains unclear. Doleman (1997:177) suggested the overwhelming dominance of hearths over roasting pits is indicative of residential sites, as opposed to logistical procurement and processing loci, where more roasting pits should be expected. But such a conclusion might gloss over the potential complexity and variation in activities carried out at different types of sites. Small-scale pit roasting, at least, may well have been a common activity at residential sites. Lipid residue data, derived from TAR in roasting pits at the US 54 sites, suggests a wide range of foods, both plant and animal, were cooked in these various earth ovens (see Chapter 28). At more specialized procurement and processing sites, we might indeed expect to find more roasting pits than hearths, assuming that large quantities of particular foods were being pit-roasted at these sites. Orogrande North (LA 128708), with its dominance of large thermal features relative to small ones, may have been a specialized resource procurement and processing locus. Given its location high on an alluvial fan, close to the uplands zone in the Jarilla mountains, processing of agave and other succulents would seem an obvious possibility for this site. Lipid residues from two roasting pits at this site, however, suggest that plant foods such as mesquite pods and prickly pear tunas may have been cooked at the site. These data do not support a specialized, agave-roasting function for LA 128708.

Patterns of TAR use in the US 54 thermal features are also of interest. Unfortunately, FCR and burned caliche were not always recorded in a consistent manner during the field investigations, frustrating attempts to systematically analyze patterns of TAR use. In most instances, both TAR counts and weights were recorded, but oftentimes TAR was only counted and not weighed, and frequently the data recorded were only estimates made in the field, rather than precisely measured numbers. For many features neither counts nor weights were provided.

Despite the shortcomings in the FCR/burned caliche database, some evidence can be extracted to address questions concerning patterns of TAR use at the US 54 sites. One question pertains to potential variability in the use of TAR material types. We can hypothesize that sites located closer to lithic sources should show a comparatively greater proportion of FCR in relation to burned caliche, while the opposite should hold for sites located further from lithic sources. Carmichael (1986:200–201), in fact, observed this pattern from his survey data in the southern Tularosa Basin. To assess this pattern for the US 54 sites,

weight data for TAR material types was examined (Table 30.2). Such data are available for Jaca (LA 6829), LA 115260, LA 115262, LA 115265, and LA 126181.[1] Although weights were recorded less frequently than counts, because of variable fracture patterns weights are considered a more reliable indicator of TAR frequencies.

To evaluate the hypothesis that the use of caliche increases with distance from lithic resources, we calculated the distance between each site and the center of the Jarilla Mountains. We then calculated the correlation of distance from the Jarillas with the proportion of burned caliche in each site's TAR assemblage (by weight), producing a correlation coefficient of 0.653, with a significance level of 0.23. Pearson's correlation coefficient is a measure of linear association, and the significance level of 0.23 indicates that these data do not represent a significant linear relationship (which is possibly affected by the small number of sites). However, the absence of a linear relationship does not imply the absence of association. Figures 30.1 and 30.2 show that the increase in caliche use is not linear, that is, it does not increase in direct proportion to distance. However, this figure shows that the percentage of caliche is greater at the sites furthest from the mountains. There is, in fact, an abrupt increase in caliche use within a few kilometers of the Jarillas, which then stabilizes at approximately 80 percent as distance increases further.

As these data clearly show, sites closer to lithic sources (in this case, the Jarilla Mountains) have TAR assemblages dominated by FCR (primarily granitic rocks), while those out on the basin floor (LA 115260, LA 115262, and LA 115265) show a predominance of burned caliche over FCR. Because caliche was readily available at all but one of the five sites included here (LA 126181), these data further indicate that rocks were preferred over caliche as heating elements, probably because of their superior durability and thermal properties. At the US 54 sites out on the basin floor, geological sources of rock are not present so the occupants of these sites were forced to use locally available caliche in place of rock as thermal heating elements.

**Table 30.2 Summary Data on TAR from US 54 sites, by Material Type (Top: Weight in grams. Bottom: Percentage by Material Type.)**

| LA Site | Burned Caliche | Granitic | Unid. Igneous | Sandstone | Unid. Sedimentary | Unknown | Totals |
|---|---|---|---|---|---|---|---|
| 6829 | 14455.9 | 47158.8 | 176.1 | 23.3 | 23593.4 | 0* | 85407.5 |
| 115260 | 11654.1 | 704.4 | 0 | 40 | 1834.8 | 0 | 14233.3 |
| 115262 | 9750 | 400 | 0* | 0* | 2000 | 0 | 12150 |
| 115265 | 116 | 0* | 0 | 0 | 29.9 | 0 | 145.9 |
| 126181 | 35.3 | 1267.5 | 4 | 0 | 346.7 | 0 | 1653.5 |
| * Counts recorded but no weights | | | | | | | |
| **LA Site** | **Burned Caliche** | **Granitic** | **Unid. Igneous** | **Sandstone** | **Unid. Sedimentary** | **Unknown** | **Totals** |
| 6829 | 16.9% | 55.2% | 0.2% | 0.0% | 27.6% | 0.0% | 100% |
| 115260 | 81.9% | 4.9% | 0.0% | 0.3% | 12.9% | 0.0% | 100% |
| 115262 | 80.2% | 3.3% | 0.0% | 0.0% | 16.5% | 0.0% | 100% |
| 115265 | 79.5% | 0.0% | 0.0% | 0.0% | 20.5% | 0.0% | 100% |
| 126181 | 2.1% | 76.7% | 0.2% | 0.0% | 21.0% | 0.0% | 100% |

1 Data on FCR and burned caliche were provided only for some of the sites investigated as part of TRC Project 27836. The small-scale investigations at the other sites in TRC Project 27836 did not produce weight data for FCR and burned caliche, and no such data could be located for the TRC Project 31577 sites (i.e., LA 128699, LA 128700, and LA 128708).



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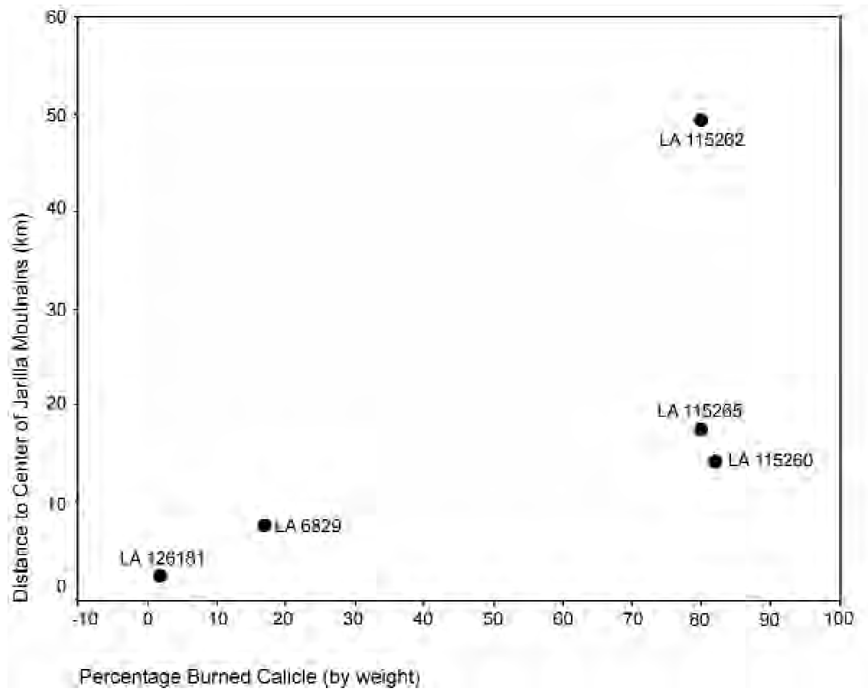


**Figure 30.1 Percentage of burned caliche at five US 54 sites, plotted against distance from the Jarilla Mountains.**

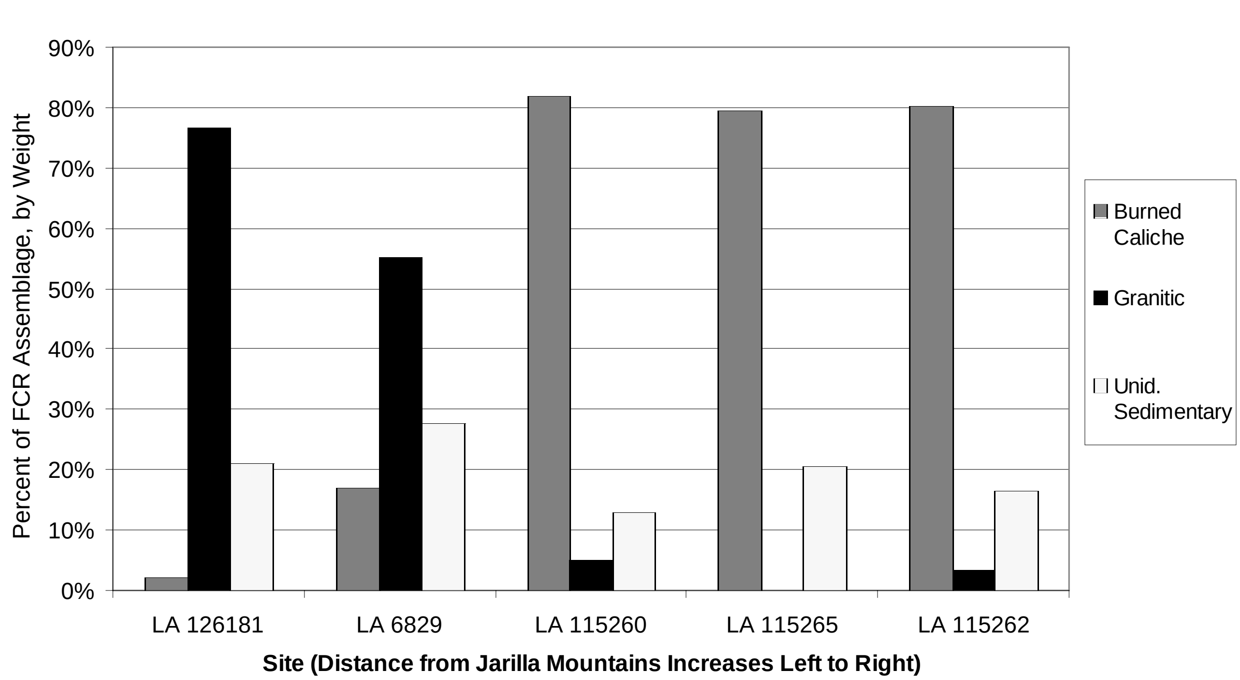


**Figure 30.2 Relative proportions of main FCR material types, by weight. Sites are listed ordinally from left to right according to distance from Jarilla Mountains.**

The preference of rock over caliche is especially evident at LA 126181, which lies high on the bajada slope of the Jarillas, with abundant lithic sources either on-site or close by. Moving down to the foot of the bajada slope, at the Jaca site (LA 6829) there is significantly more burned caliche than at LA 126181, although FCR still dominates. Moreover, the burned caliche numbers at Jaca are skewed considerably by Feature 5. This feature was an FCR concentration that contained an estimated 13 kg of burned caliche, or 90 percent of the burned caliche (by weight) reported from the site. Between Jaca and LA 115260/LA 115265, there is a clear break in this pattern, with TAR assemblages at the latter two sites overwhelmingly dominated by caliche. These latter sites are located only a short distance to the south of Jaca, but still beyond the toe of the bajada slope, out on the basin floor.

The US 54 data support Carmichael's observation that the "differential use of rock and caliche is directly related to distance from rock sources" (1986:200–201). The data also support his argument that caliche and rock were viewed as functionally interchangeable (Carmichael 1986:200–201), although obviously rock was preferred to caliche, and used wherever it was available. Accordingly, the data do not appear to support O'Laughlin's earlier suggestion that "caliche hearths are functionally distinct from rock hearths" (1979:69). The critical factor in the use of caliche versus rock in thermal pits appears to be, simply, distance from sources of abundant rock. As discussed above, thermal pit *size* is probably a better indicator of function than TAR type in the pit fill. Carmichael (1986:200) makes the same point.

Along with geological sources of rock, fragmented ground stone milling implements provided an additional source of potential TAR materials. While it seems unlikely that large quantities of rock would be transported great distances expressly for use in thermal pits, milling implements were transported deep into the basin interiors. Once broken and rendered nonfunctional, these artifacts and fragments were regularly scavenged for use as heating elements in thermal pits. Accordingly, at sites that were occupied repeatedly, accumulations of ground stone fragments provided an artificial source for TAR (Carmichael 1986:200).

To assess the frequency of ground stone recycling for use as TAR, consider Table 30.3, which shows the percentage of ground stone found in thermal features, by site (for sites that produced more than 10 pieces of ground stone). As might be expected, LA 115262—the only basin-floor site to produce more than 10 pieces of ground stone—had the highest percentage of its ground stone assemblage occurring in thermal features. Again, LA 115262 was far from geological sources of rock, and its inhabitants were forced to rely primarily on caliche for use as TAR (see above). At this site, ground stone fragments would have presented an attractive alternative to caliche and were probably intensively scavenged for use as TAR. Orogrande 1 (LA 128699) evidenced the second highest rate of ground stone–FCR recycling. The high rates at these sites further underscore the apparent preference of rock over caliche as heating elements in thermal activities.

**Table 30.3 Percentages of Ground Stone Artifacts Found in Thermal Features (Including FCR Concentrations), at Sites Producing More Than 10 Pieces of Ground Stone**

| LA Site | Percent (by weight) | Percent (by count) |
|---|---|---|
| 6829 | 6.78 | 5.88 |
| 115262 | 25.37 | 31.25 |
| 128699 | 14.49 | 19.72 |
| 128700 | 0.00 | 0.00 |

The high rates of ground stone recycling at these two sites may also be symptomatic of site chronology. Both Orogrande North and LA 115262 were occupied repeatedly during the Late Archaic and Mesilla phases. The high-mobility settlement patterns of these periods enabled regular access to rock sources and long-distance transport of milling implements, even to interior basin sites (like LA 115262). Repeated



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occupations at both Orogrande 1 and LA 115262 resulted in accumulations of ground stone debris, which the later inhabitants of these sites could scavenge for use as TAR (even though the locally available caliche remained the mainstay for use in thermal pits at LA 115262). Orogrande 1, situated on the bajada of the Jarilla Mountains, was much closer to geological sources of rock (and indeed, FCR predominates over burned caliche in its TAR assemblage), but fragmented ground stone littering the site's surface still presented an attractive source of rock for use in thermal pits.

At LA 115260 and LA 115265, the apparent low incidence of ground stone recycling (and ground stone itself), as well as the high rates of caliche in the TAR assemblages, may also be explained in part by temporal factors. These two sites, which may have been parts of a single, dispersed community, were occupied over a relatively short span of time during the Doña Ana phase. By this time in local prehistory, group mobility and, presumably, territorial access to various resources, were considerably reduced (see Whalen 1981a). The single-component occupancy of these sites meant that there was no pre-existing, on-site supply of ground stone fragments or TAR discarded from earlier occupations. Despite the fact that LA 115260 and LA 115265 were much closer to geological sources of rock than was LA 115262, the absence of accumulated ground stone debris and perhaps territorial circumscription, forced the Doña Ana-phase occupants of these sites to rely just as heavily upon caliche for use as a TAR.

In terms of TAR use in thermal features, systematic, comparative analyses are not advisable, given the data deficiencies previously explained. These deficiencies limit any attempt to sort out, for example, thermal pit types defined primarily by TAR content (Types A–D, see above). From an examination of the FCR/burned caliche data, along with feature forms and photographs, it appears that there are many Type A thermal pits (i.e., those lacking TAR) at the US 54 sites, and Type D features (non-pit, TAR concentrations) are common as well. Pits with TAR fill (Type C) appear to be common as well, although the amount of TAR fill in thermal pit varies considerably. Type B features (thermal pits lined, or partially lined, with TAR), appear to be relatively rare, and at best are only partially lined with TAR. Feature 2 at LA 115262 (see Chapter 10, Figures 10.10 and 10.11), and Features 25 and 64 at Orogrande 1 (see Chapter 14, Figure 14.12) appear to be examples of Type B thermal pits. Much of the TAR fill in pits, however, was apparently redeposited as secondary fill, although these materials may have been used in the pits they were re-deposited back into. With few exceptions pit-cooking techniques at the US 54 sites were apparently such that TAR, when used, was regularly removed following each cooking episode, and either deposited outside of features, or dumped back into the pits.

### ***US 54 Non-thermal Pits***

The presence and relative proportions of non-thermal pits can provide important information relevant to site function. Specifically, the presence of non-thermal pits, especially storage facilities, would indicate an appreciable level of investment in site occupancy and anticipated use-duration of a particular camp or settlement. Accordingly, one useful measure involves site-by-site ratios between thermal and non-thermal pits, and Table 30.4 presents these data for the excavated US 54 sites.

As Table 30.4 shows, non-thermal pits were consistently far fewer in number than thermal pits, with six of the 11 data recovery sites producing no non-thermal pits. Only the Jaca site (LA 6829) contained a large number of non-thermal pits. This site also had the lowest ratio of thermal to non-thermal pits, among sites that had more than six excavated pit features (which includes LA 115262, LA 126181, Orogrande 1 [LA 128699], Orogrande 2 [LA 128700], and Orogrande North [LA 128708]). If we assume that non-thermal pits are indicators of storage and other activities that would be expected at more intensively occupied, longer-term residential sites,



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**Table 30.4 Numbers of Excavated Thermal vs. Non-thermal Pits at the Data Recovery Sites**

| Site | Thermal | Non-thermal | Thermal: Non-thermal | Temporal Components |
|---|---|---|---|---|
| LA 6829 | 71 | 31 | 2.3:1 | Formative (Doña Ana/El Paso) |
| LA 115256 | 2 | 0 | 2:0 | Formative (Mesilla) |
| LA 115259 | 1 | 0 | 1:0 | Formative (Mesilla) |
| LA 115260 | 4 | 2 | 2:1 | Formative (Doña Ana) |
| LA 115262 | 30 | 4++ | 7.5:1 | Late Archaic (Hueco) and Formative (Mesilla) |
| LA 115263 | 1 | 0 | 1:0 | Unknown |
| LA 115265 | 3 | 0 | 3:0 | Formative (Doña Ana) |
| LA 126181 | 20 | 1 | 20:1 | Formative (Mesilla and Doña Ana) |
| LA 128699 | 84 | 3 | 28:1 | Primarily Late Archaic (Fresnal); smaller Formative (Mesilla) |
| LA 128700 | 25 | 0 | 25:0 | Late Archaic (Hueco) and Formative (Doña Ana) |
| LA 128708 | 11# | 0 | 11:00 | Late Archaic (Hueco) and Formative (Mesilla) |

* Excludes eight large, non-thermal features interpreted as possible huecos

++ All non-thermal pits at this site were located within the postulated Structure 2

# Excludes four small thermal features that were historic in age.

then these numbers clearly highlight Jaca as this type of site. Only LA 115260 produced a lower ratio of thermal to non-thermal pits, and although this may be the result of small sample size, the relatively high proportion of non-thermal pits at this site is consistent with other lines of evidence (i.e., the Feature 1 midden deposit, and the prepared floors that were partially uncovered outside the right-of-way) indicating this was also an intensively occupied, residential settlement. Both Jaca and LA 115260 are Late Formative sites. The high proportions of non-thermal pits at these two sites are potentially consistent with the trend toward reduced mobility at this time and the appearance of residential sites that were occupied intensively for at least several months of the year.

All of the other US 54 sites contain higher ratios of thermal to non-thermal pits, suggesting they were less intensive, shorter-term occupations, or perhaps somewhat specialized, logistical sites used for collecting and processing specific resources. The large numbers of features at some of these sites would appear to indicate many repeated, short-term occupational episodes rather than intensive, residential habitation. These sites range from the Late Archaic period to the late Formative period. At some of these sites, there may have been short intervals of more intensive, residential occupation. Such intervals may include the early Mesilla-phase occupations at Orogrande 1 and LA 115262, each of which contained pithouses, and possibly also the Fresnal phase pithouse (Structure 3) at Orogrande 1. But even assuming such intervals occurred at these sites, they still appear to have been much smaller-scale and/or shorter-lived settlements than were the occupations at Jaca and LA 115260.

The non-thermal pits are of varying size and morphology, suggesting similarly variable functions. Table 30.5 presents size and morphology data on non-thermal pits from the US 54 sites. Jaca (LA 6829) was the only site containing clear examples of cylindrical and bell-shaped pits of substantial size. Assuming these were used for storage of maize, then Jaca may have been the only US 54 occupation where this mode of storage was maintained on-site. Jaca contained seven presumed storage pits, which ranged in preserved depth 22–76 cm. This is a further indicator of the intensive, long-term, and residential function of this site, which sets it apart from the others. At LA 115260, one of the two excavated non-thermal pits was only partially cylindrical in profile, and at 14 cm in depth was much shallower than any of the probable storage pits at Jaca. Even at Jaca, however, the number of apparent storage pits represents only a very small proportion of the pit features uncovered at this site. This suggests that pit



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**Table 30.5 Morphology and Size Data on Non-thermal Pits from the US 54 Sites**

| LA Site | Profile Morphology | | | |
|---|---|---|---|---|
| | Basin | Cylindrical | Bell | Other |
| 6829* | N=22 | N=5 | N=1 | N=3 |
| | Max. Diameter: Ra. 0.27–2.75 m, Mean 0.80 m; Depth: Ra. 2–37 cm, Mean: 14.6 cm | Max. Diameter: Ra. 0.39–1.78 m, Mean 0.99 m; Depth: Ra. 22–76 cm, Mean: 49.4 cm | Max. Diameter: 1.05 m; Depth: 37 cm | Max. Diameter: Ra. 0.20–1.14 m, Mean 0.58 m; Depth: Ra. 8–44 cm, Mean: 30.7 cm |
| 115260 | N=1 | N=0 | N=0 | N=1 |
| | Max. Diameter: 0.66 m; Depth: 37 cm | | | Max. Diameter: 2.46 m; Depth: 41 cm |
| 115262# | N=4 | N=0 | N=0 | N=0 |
| | Max. Diameter Ra. 0.20–0.24 m, Mean 0.22 m; Depth: Ra. 4–9 cm, Mean: 6.8 cm | | | |
| 126181 | N=1 | N=0 | N=0 | N=0 |
| | Max. Diameter: 0.28 m; Depth: 8 cm | | | |
| 128699 | N=3 | N=0 | N=0 | N=0 |
| | Max. Diameter: Ra. 0.12–0.60 m, Mean 0.31 m; Depth: Ra. 5–14 cm, Mean: 8.0 cm | | | |

* Excludes eight large, non-thermal features interpreted as possible huecos
# All non-thermal pits at this site were located within the postulated Structure 2

storage of food may have been somewhat sporadic at this site, and that storage at Jaca may also have involved other methods, perhaps including above-ground facilities and/or designated spaces within the possible room block represented by Structures 1 and 3.

## Summary

Pit features provide an important line of evidence pertaining to functional variation among the US 54 sites. The vast majority of pits were thermal facilities, and thermal pits typically far outnumbered non-thermal pits at each of these sites. Small thermal features (probably hearths) typically outnumber their larger counterparts (probably roasting pits), although the Orogrande North site (LA 128708) is a notable exception here. Even though the sample size of excavated features was small at Orogrande North, surface evidence outside the right-of-way suggests there may be many more large roasting ones at this site, which may have been a comparatively specialized locality used for communal cooking activities.

Use of different TAR material types varies with distance from geological sources of rock. At sites on the bajada of the Jarilla Mountains, TAR assemblages are dominated by burned rock, whereas burned caliche dominates at the basin-floor sites. These data indicate that rock was preferred to caliche as a heating element for use in thermal pits, and that caliche was resorted to only when abundant lithic sources were not locally available. Fragments of ground stone milling implements were frequently recycled for use as TAR, and this option was enhanced at sites that were occupied repeatedly, where ground stone debris tended to accumulate over time.

Non-thermal pits were considerably rarer than thermal pits in the US 54 sites, and were absent at six of the 11 data recovery sites. Only the Jaca site (LA 6829) contained significant numbers of



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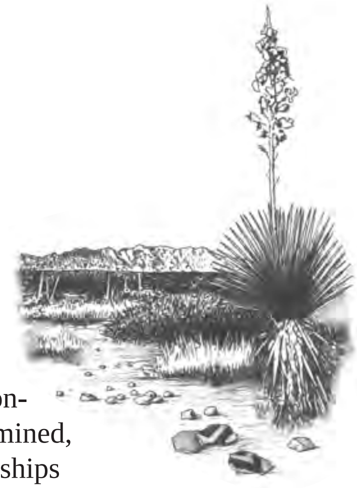
non-thermal pits. This was the only site where relatively deep, cylindrical and bell-shaped pits were uncovered. These data underscore the fact that among the US 54 sites, Jaca was in a class by itself in terms of site function, being the only one of the eleven sites that clearly hosted a large, intensive occupation spanning a multi-year period. Only LA 115260 may have approached Jaca in terms of occupational intensity, although the scale of this settlement appears to have been much smaller or perhaps more spatially dispersed. All of the other sites involved smaller scale, more ephemeral occupations, although repeated use of some of these sites (especially Orogrande 1 [LA 128699]) left many features and extensive distributions of archaeological debris. Two of the smaller sites (LA 115262 and LA 128699), along with Jaca, contained the remains of house structures. It is this feature type, and the settlement implications of structure variation at the US 54 sites, that are the subject of the next chapter.

Chapter 31

# HOUSES AND SETTLEMENT PATTERNS

*Jim A. Railey*



TRC's testing and data recovery excavations along US 54 provide significant new information on prehistoric occupations and settlement patterns in the Jornada Mogollon region. Excavations at Jaca (LA 6829), Orogrande 1 (LA 128699), and LA 115262 uncovered structures dating from the early Late Archaic Fresnal phase, the Mesilla phase, and the Late Formative period (Doña Ana and El Paso phases). In addition, excavations at LA 115260 and LA 115265 encountered remains that appeared to be from Doña Ana-phase domiciles, although no structures could be formally defined.

Interpreting the significance of the data recovery findings for regional settlement and sociopolitical patterns requires that these findings be linked to the theoretical orientation and address the research questions outlined in the research design (Chapter 4). This chapter builds on the ideas and questions set forth in Chapter 4 and also touches upon certain trends and issues described in the cultural history (Chapter 3).

The settlements investigated in this study were occupied mostly during periods when pithouses were the primary type of residential structure in use, and the time span covered by the project sites concludes with the El Paso phase, when prehistoric peoples in the central Jornada region began building room-block pueblos. Accordingly, this section begins with a brief discussion of previous studies concerning the settlement implications of pithouse sites and some analytical techniques that have been used to investigate pithouse settlement variability. This chapter then proceeds to a discussion of the significance of our findings for regional settlement and sociopolitical trends, organized by the relevant time periods: 1) Late Archaic; 2) Mesilla phase; and 3) the Late Formative. For each of these periods, the character of each occupational component is examined, the potential relationships between components of each period are explored, and sociopolitical patterns, based on presently known regional patterns and relevant theoretical models of social organization and change, are discussed.

## Previous Studies of Mogollon Pithouses

Because nearly all of the structures excavated at the US 54 sites were pithouses, it is useful to consider previous studies involving analyses of pithouse settlements in the Mogollon region. Note that the models and analyses highlighted here deal with the Pithouse periods only, which in the Jornada includes the Mesilla and Doña Ana phases. This time frame traditionally has been viewed as marking a substantial break from the Late Archaic in terms of residential stability and agricultural dependence. Despite the fact that the existence of Late Archaic pithouses has been known for many years, until recently they generally have not been included in past analyses and discussions of pithouse settlements. Most of these studies deal with Mogollon pithouse sites west of the central Jornada region, but they are nonetheless applicable to a broader consideration of pithouses.

Ideas and models concerning the implications of pithouse sites for settlement patterns in the Mogollon area have changed over time and vary between different scholars interested in the subject. Earlier investigators saw the appearance of pithouse settlements as signaling the abandonment of mobile settlement strategies and a shift toward sedentism with permanent, agricultural communities (cf. Haury 1962:115–117; LeBlanc



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1980; Lightfoot and Feinman 1982; Martin and Plog 1973; Sayles and Antevs 1941:26; Steward 1955:62). In recent years, however, most researchers have come to the conclusion that most pithouse dwellers were seasonally mobile to some degree. Recent ideas surrounding pithouse mobility have been grouped by Diehl (1997:181–183) into three major models. The first model holds that pithouse settlements were occupied primarily during the winter months (Gilman 1987; Hunter-Anderson 1986). The second group of ideas paints pithouse settlement patterns as dynamically variable and changing, with some sites occupied seasonally and others more or less year-round (Lightfoot and Jewett 1986; Mauldin 1991, 1993). Finally, Lekson (1989, 1992) suggests that both pithouse and pueblo dwellers in the Mogollon region were highly mobile, engaged in both foraging and agriculture, and moving seasonally between high and low elevation settings.

Lightfoot and Jewett (1986) and Diehl (1997) conducted separate studies focused on Mogollon pithouse occupational intensity and duration of use. Lightfoot and Jewett questioned the then prevailing notion that the appearance of pithouse settlements marked a shift to full-fledged sedentism. Inspired by their findings at Duncan, a seasonal early Mogollon pithouse site, Lightfoot and Jewett suggested "that variations in the occupation durations of residential sites probably occurred in response to changing local and regional conditions" (1986:13). Using the same sites included in Lightfoot and Feinman's (1982) study, their analysis set out to test this assumption by measuring several variables relating to occupational duration of pithouse villages. Their variables included: 1) presence/absence of interior hearths; 2) density and diversity of artifacts; 3) number of burials; 4) depth and extent of middens; and 5) energy invested in architecture (i.e., numbers of postholes, internal features, floor preparation).

By measuring these attributes, pithouse settlements can be plotted against two axes: residential stability (i.e., seasonal vs. year-round) and duration of site use over time. Sites thus could potentially fall at or between four extremes: 1) warm-weather seasonal settlements occupied for only a brief period of time; 2) warm-weather seasonal sites repeatedly occupied over a long period of time; 3) residentially stable (i.e., winter or year-round) settlements occupied for a brief period of time; and 4) residentially stable sites occupied for a long period of time. According to the results of their analysis, Lightfoot and Jewett indeed found significant variation among different pithouse settlements, as they relate to these respective scenarios. Accordingly, they argued that the shift to sedentary village life was gradual, dynamic, and oscillating.

In a more recent article, Diehl (1997) examined anticipated use life of upland Mogollon pithouses and in doing so challenged the findings of Lightfoot and Jewett, as well as those of other researchers in the area. Diehl considered attributes reflecting investment in pithouse construction as measures of residential commitment at different settlements. Unlike Lightfoot and Jewett, Diehl was interested in diachronic variation over the course of the Pithouse periods and examined patterns of anticipated use life by measuring six attributes:

> 1) formality of hearth construction; 2) presence or absence of interior plaster; 3) materials used in wall construction; 4) density of vertical support posts per square meter of floor space; 5) depth of house pits; and 6) evidence of remodeling (Diehl 1997:185).

Diehl contends "that all pithouses had an internal heating source" (1997:186), and so he argues presence/absence of hearths, a prominent variable in Lightfoot and Jewett's analysis, is an irrelevant measure. Rather, Diehl scored hearth preparation according to the degree of investment, beginning with simple, informal surface hearths through increasingly "expensive" types represented by simple basin hearths, hearths fronted by a deflector slab, and slab-lined hearths. In the lowland portions of the Jornada Mogollon region, prepared

adobe hearths can be considered the investment equivalent of the slab-lined types found in the upland Mogollon sites examined by Diehl.

Presence or absence of interior plaster, density of support posts, and depth of house pits are all self-explanatory. With respect to floor preparation, however, one might add hard-packed floors as an intermediate variable between unprepared and plastered floors. By "materials used in wall construction," Diehl refers to the absence or presence of construction stone. Stone construction was generally not used in lowland portions of the Jornada Mogollon region, and here adobe construction can be considered the investment equivalent of stone masonry.

Proceeding with his analysis, Diehl found significant trends indicating overall increases in anticipated use life, from the Early Pithouse period (contemporary with the Early Mesilla phase in the central Jornada region) through the three phases of the Late Pithouse period (contemporary with the middle and later portions of the Mesilla phase). He interpreted these patterns as indicating a progressive decrease in residential mobility and increasing residential commitment to, and architectural investment in, pithouse sites. Diehl (1997:191) concluded that Pit House-period settlement patterns ranged from seasonal, residentially mobile patterns with moderate dependence on agriculture during the Early Pit House period, to "very logistically organized and highly dependent on agriculture" by the Three Circle phase (contemporary with the Late Mesilla). In the Jornada Mogollon, a similar, Pithouse-period trend is evident, but on somewhat lagged time scale, culminating with the formalized, high-investment pithouses and agricultural-based subsistence economies of the Doña Ana phase (see Chapter 3). To assess the occupational duration and anticipated use life of structures uncovered during the US 54 project, this study considers the variables used in the analyses by both Lightfoot and Jewett, and by Diehl. In addition to these measures, information on pithouse size and form are important considerations that are treated here.

As discussed in Chapter 3, evolutionary changes in pithouse form are evident in the Jornada Mogollon region. The sequence begins with small, shallow, saucer-shaped pit structures, which are the sole form in the central Jornada Late Archaic. These are referred to here as simple basin-type pit structures (see Chapter 3). These small huts are always circular or oval, typically lack visible postholes, contain only simple, informal hearths, and sported either brush or daub superstructures. During the Mesilla phase, some pithouses become deeper and more substantial, and exhibit a clean break between the walls and floor. Postholes are often evident, and basin hearths and interior storage pits may also be present. Those which lack plastering are referred to here as simple pit-type pithouses. Plastered floors indicate more formalized pithouses, and these also appear by the late Mesilla phase. Both simple pit-type and formalized pit structures include curvilinear and rectilinear forms. By the Doña Ana phase, even more formalized pit structures emerge, culminating with the square and rectangular adobe houses with the hearth-step arrangement at the late Doña Ana Hueco Tanks sites, and these distinctive features presage those of local puebloan architecture in the subsequent El Paso phase (see Chapter 3). Adobe pueblos or stand-alone rooms characterize El Paso-phase architecture, although Jornada peoples also continued to build pithouses of all varieties. Throughout the Jornada sequence the earlier, more rudimentary structure forms do not simply vanish with the appearance of new and more sophisticated kinds of houses. Rather, there is often a mix of different structure types both within and between sites, and the US 54 project results underscore this interesting phenomenon.

## The Investigated Components and Settlement Patterns through Time

### ***Late Archaic***

Late Archaic components were documented at three of the US 54 data recovery sites. Excavations at Orogrande 1 (LA 128699) uncov-



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ered an extensive early Late Archaic, Fresnal-phase component, complete with numerous pit features (mostly thermal), abundant artifact remains, and a simple-basin pithouse. This pithouse, Structure 3 (see Chapter 14, Figure 14.8), is the earliest dated structure from the project, with calibrated, two-sigma radiocarbon determinations of 2140–1920 B.C. (Beta-161806) and 1910–1700 B.C. (Beta-161807). This is roughly contemporary with the Late Archaic pithouse sites at Keystone Dam, located on the lower bajada of the Franklin Mountains in northwest El Paso (see Chapter 3). The Orogrande 1 site is similarly situated, on the lower bajada of the Jarilla Mountains.

Structure 3 is typical of Late Archaic pithouses in the central Jornada region, consisting of an oval, shallow basin with a simple, informal hearth, and no postholes or other interior features. At 6.2 $m^2$ it is very similar to the structures at Keystone Dam, and also is well within the range of Late Archaic pithouses uncovered in basin floor settings elsewhere in the central Jornada region (Figure 31.1). Its ephemeral nature is also consistent with high-mobility settlement patterns that characterize the Jornada Late Archaic. The fact that only one pithouse was uncovered within the extensive Late Archaic component is of interest. It is possible that other pithouses were present, but have been destroyed by erosion; however, archaeological remains at Orogrande 1 were protected by generally deeper sand deposits than were present at most of the other US 54 sites, potentially discounting the possibility of feature attrition through taphonomic processes. The Fresnal-phase component at Orogrande 1 apparently covered a long time span (see Chapter 14), and assuming Structure 3 was indeed the only (or one of only very few) pithouse associated with this component, then it might be the case that the nature of the Fresnal-phase occupation at this site varied over time. Specifically, the construction of Structure 3 may have represented an attempt to establish a base camp-type settlement at this site, but failed to attract followers. Alternatively, Structure 3 may simply represent an isolated, single-family camp or was perhaps part of a more dispersed camp that included other pithouses located beyond the investigated portions of this site. Most of the Fresnal-phase occupation at Orogrande 1, as well the smaller Hueco-phase component, appear to have involved many small-scale camps that left behind mostly thermal features and scattered artifacts. If there were any other structures built during the Late Archaic occupations at this site, they were so ephemeral that they left no archaeological traces.

Similar, structureless Late Archaic components were documented at LA 115262 and Orogrande North (LA 128708) (see Chapters 10 and 16). LA 115262 lies in the middle of the basin floor and is typical of many Late Archaic occupations documented in this locational context. The Late Archaic component at this site includes both Fresnal- and Hueco-phase occupations, and included thermal features only. LA 128708 lies high on the bajada of the Jarillas and contained mostly large thermal features. The Late Archaic component at this site appears to date primarily from the Hueco phase. Again, structures were probably present at these sites, but if so were ephemeral and not detectable archaeologically.

All the US 54 Late Archaic components appear to be consistent with small-scale family-level groups (cf. Johnson and Earle 1987) pursuing highly mobile, settlement-subsistence patterns. Although domesticated maize has been documented for this period in the central Jornada region (see Chapter 3), no evidence for domesticates or agricultural activities were encountered in the US 54 Late Archaic components. This contrasts sharply with other Late Archaic sites in southern New Mexico and Arizona that have yielded abundant evidence of both maize agriculture and substantial pithouses and storage pits (e.g., Huckell 1995; Mabry 1998; Mabry *et al.* 1997; Turnbow 2000). In the central Jornada, it appears that Late Archaic groups were still largely hunter-gatherers, and the US 54 data are certainly consistent with this scenario. As with other major developments in the prehistoric Southwest, the adoption of agriculture



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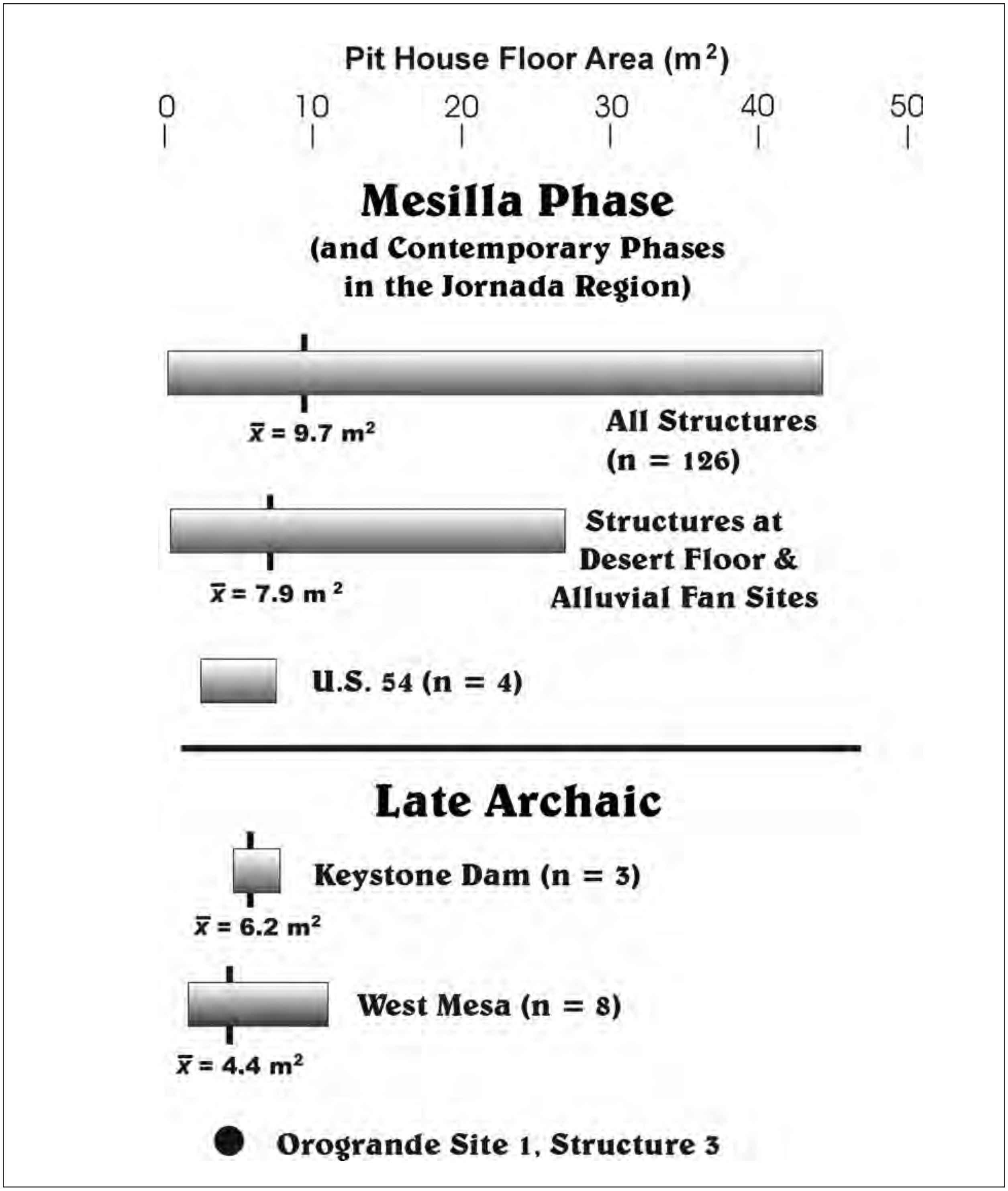


**Figure 31.1** Size relationships between US 54 Late Archaic and Mesilla-phase structures, and those from other sites excavated elsewhere in the Jornada Mogollon region (see Chapter 3 for corresponding structure size data).



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as a major part of subsistence strategies appears to have lagged temporally in the central Jornada region.

## *Mesilla Phase*

Mesilla-phase components were documented at seven of the US 54 data recovery sites (see Table 31.1). Two of the sites, Orogrande 1 (LA 128699) and LA 115262, included pit structures (see Chapters 10 and 14). Up to four Mesilla-phase pithouses were documented at Orogrande 1. One pithouse (Structure 2) was fully excavated, most of another (Structure 1) was uncovered, and only small portions of the other two (Structures 4 and 5) were exposed. All four of the Mesilla-phase structures were located in a tight cluster at the northern end of this otherwise mostly Late Archaic site, and additional structures may be present nearby, outside of the impact area. Two-sigma, calibrated radiocarbon dates from Structures 1 and 2 are nearly identical: A.D. 610–880 for Structure 1 and A.D. 620–880 for Structure 2. These dates are consistent with the associated undecorated brownware sherds and the complete absence of any decorated wares. These dates are also consistent with a series of Mesilla-phase dates from several non-structural features and the scatter of plain brownwares concentrated in the northern portion of the site (see Chapter 14).

All of the Mesilla-phase structures at Orogrande 1 are simple pithouses, with no indicators of formalized preparation such as plastered floor, walls, or hearths. Only Structures 1 and 2 were uncovered to the extent that their form and other attributes could be determined. Both are simple pit-type pithouses. Structure 1 was rectangular in shape, with the excavated portion covering 8.5 $m^2$. Structure 2 was oval in shape, with a floor area of 8.5 $m^2$. Structure 1 contained two interior hearths and Structure 2 contained an interior hearth and two non-thermal features. The larger of the two non-thermal features in Structure 2 may have been a small, sub-floor storage bin. The smaller of the two non-thermal features in Structure 2 may have been a posthole, but it was extremely shallow and so if it was a posthole, it may well have been an intrusive feature. Otherwise, this small depression may have been a pot rest. No other possible postholes were found in either of these pithouses, nor was any daub encountered; they probably had rather expedient frames and brush-covered superstructures. Structure 2 also had an entry ramp or ventilator that extended off the east side of the pithouse.

At LA 115262, one Mesilla-phase pit structure was excavated, and another was hypothesized from a locally dense cluster of features. In addition, two probable pithouse stains were identified on the surface outside the right-of-way, although their temporal affiliations remain unknown. The one excavated structure here is a simple basin-type pithouse, with widely rounded corners and a small floor area (3.6 $m^2$). It contained an interior hearth but no other pit features and no postholes. A radiocarbon sample from the interior hearth of this pithouse yielded a two-sigma, calibrated date of A.D. 230–550, which falls within the early Mesilla phase. No ceramics were recovered from the pithouse itself, although a few brownware sherds came from its immediate vicinity.

**Table 31.1 Characteristics of Mesilla-phase Pithouses from the Project Area**

| LA Site | Structure | Floor Space ($m^2$) | Depth ($\geq$) (cm) | Hearth Type | Internal Pits? |
|---|---|---|---|---|---|
| 115262 | 1 | 3.6 | 17 | Simple Basin | No |
| 115262 | 2 | 4.3* | Unknown | Simple Basin ? | Yes |
| 128699 | 1 | 8.5+ | 31 | Simple Basin | No |
| 128699 | 2 | 8.5 | 37 | Simple Basin | Yes |
| 128699 | 4 | Unknown | 5+ | Unknown | Unknown |
| 128699 | 5 | Unknown | Unknown | Unknown | Unknown |

* Structure inferred from a tight cluster of features



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Near Structure 1 is a cluster of extramural features, although it is not clear how many of these may be contemporary and associated with the pithouse. At least one of these extramural pits, Feature 2, appears to pre-date Structure 1, judging from its associated radiocarbon date of 370 B.C.–A.D. 220 (Beta-156963; calibrated, two-sigma). Feature 2, however, contained ceramics suggesting it is a very early Mesilla-phase pit, and probably close in time to Structure 1.

A second, possible pithouse was also identified at LA 115262. No house pit or other architectural remains were present; rather, this structure was inferred from a tight cluster of features intruding below a deflated surface. These include four small non-thermal pits, three postholes, and a large oval pit that may include both a hearth and an entry ramp. These features probably represent the lower portions of sub-floor pits, with the pithouse basin itself likely destroyed through deflation. There are no chronometric dates from this cluster of features. The presence of brownware sherds at this locality argues for an early-to-middle Mesilla phase affiliation. One possible Playas Red sherd (dating from Late Formative times) was recovered from the surface above these features. Without the house basin itself, little can be said about the form or type of pit house this might have been, although the feature cluster suggests an oval structure with a floor area of about 4.3 $m^2$.

Many Mesilla-phase pithouses have been excavated in the Jornada Mogollon region (see Chapter 3), and so it is worth comparing those from the US 54 project with the existing database. Looking at Figure 31.1, it can be seen that the two Mesilla-phase pithouses from Orogrande 1 are slightly smaller than the average size of Mesilla-phase pithouses. The two at LA 115262 are even more toward the small end of the range. Although the sample size is obviously too small to make any meaningful comparisons, the Mesilla-phase structures at Orogrande 1 and LA 115262 are potentially consistent with settlement patterns observed by Whalen (1994a, 1994b) for both the Late Archaic period and the Mesilla phase. Specifically, Whalen suggested larger and more substantial pithouses tend to occur at basin-edge and riverine sites (see Chapter 3). While Orogrande 1 is not a true basin edge site, it does lie on the alluvial apron of the Jarilla Mountains, in a basin edge-like context. The Mesilla-phase pithouses at Orogrande 1, however, are not nearly as large, nor are they as substantially constructed, as those from Turquoise Ridge, Whalen's quintessential basin-edge site for the Mesilla phase (see Figure 31.2). The US 54 pithouses are, in fact, all within the range of Whalen's *small* Mesilla phase structure. Also, unlike Turquoise Ridge, there are no large storage pits or formalized pithouses in the US 54 Mesilla-phase components, nor is there any evidence of agricultural production. While Turquoise Ridge is one of Whalen's few Mesilla-phase Class 1 sites, the Mesilla-phase components at both Orogrande 1 and LA 115262 are inclusive within Whalen's Class 2 or 3 site category (see Chapter 3, Table 3.2).

The pithouse-size dichotomy between the two US 54 sites is also worth noting in the context of Whalen's study. The fact that the US 54 pithouses located within a basin edge-like setting (Orogrande 1) are larger than those identified in the basin floor zone (LA 115262) parallels Whalen's settlement dichotomy, if only in microcosm. This may indicate slight differences in terms of function, seasonality between the Orogrande 1 and LA 115262 Mesilla-phase components, with Orogrande 1 perhaps involving a somewhat more extended season of occupation and a longer anticipated use-life for its structures. But these differences are slight at best, and both of these components appear to be the remains of small, seasonally occupied camps that were part of a logistically mobile settlement pattern typical of the Mesilla phase. According to the pithouse attributes examined by Lightfoot and Jewett (1986) and Diehl (1997), the US 54 Mesilla-phase structures all score rather low in terms of architectural investment and residential commitment. This is consistent with the standard image of Mesilla-phase peoples as seasonally mobile.



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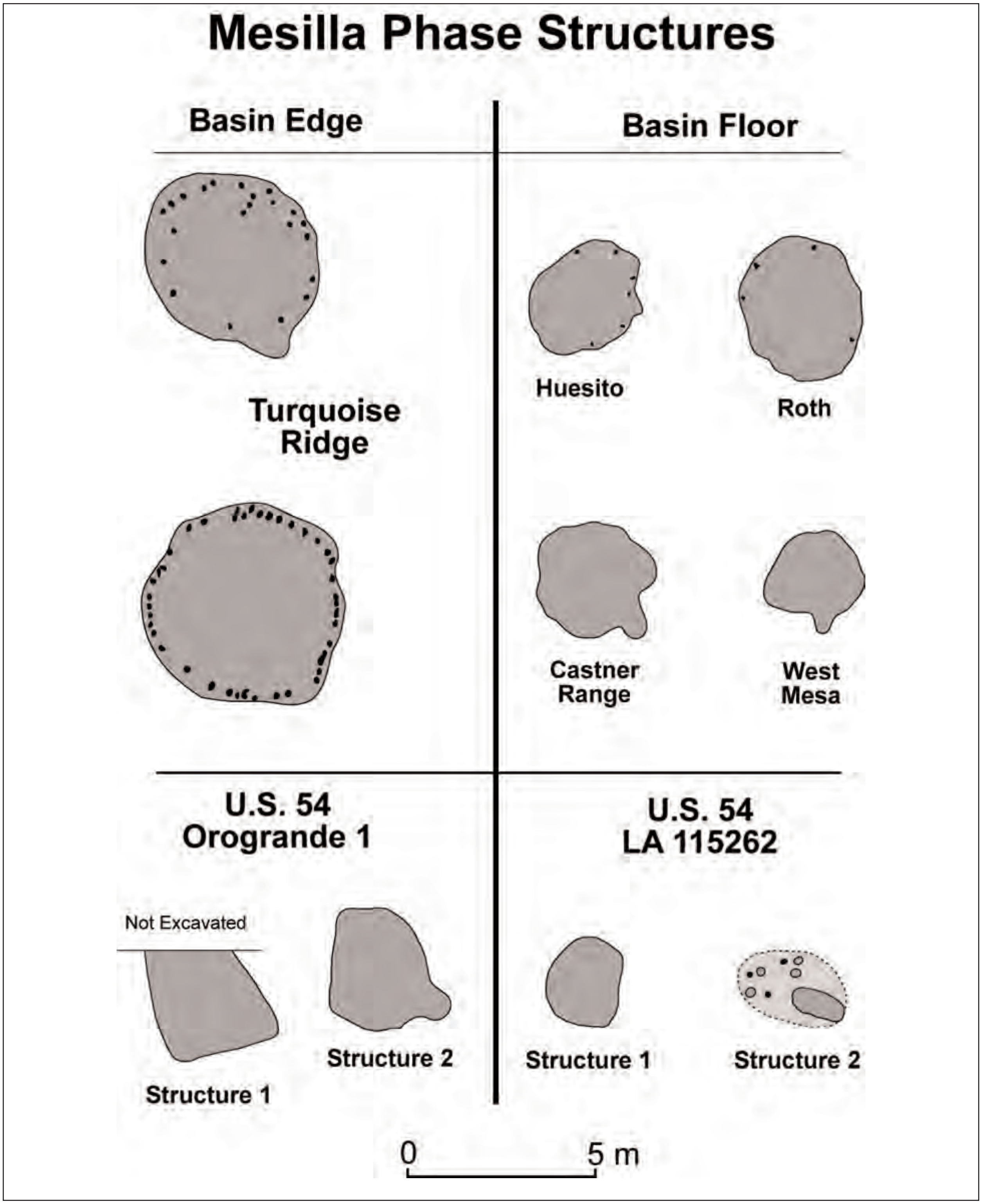


Figure 31.2 Comparison of the US 54 Mesilla-phase structures with selected examples from elsewhere in the Jornada Mogollon region (see Chapter 3 for site references).



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Temporal considerations may also be relevant to understanding the broader settlement context of the US 54 Mesilla-phase pithouse components. With the exception of Turquoise Ridge, all of the known large (i.e., Class 1) Mesilla phase sites date exclusively within the late portion of this phase (i.e., post-ca. A.D. 800). Turquoise Ridge appears to have been occupied slightly earlier and includes both middle (ca. A.D. 500–700) and late (ca. A.D. 700–900) components, with the large, communal structure at this site dating from the latter of the two components. Accordingly, there is at present no evidence to suggest that early Mesilla-phase (ca. A.D. 200–500) settlement patterns were any different from those of Late Archaic times, involving small-scale family groups pursuing highly mobile annual rounds, with even base-camp pithouses being rather small. Base camp sites with larger pithouses and storage facilities, such as Turquoise Ridge, may not have emerged until middle Mesilla times, with large, communal structures at these sites perhaps appearing only after ca. A.D. 800 (see Whalen 1994b:52). The radiocarbon date from Structure 1 at LA 115262, along with the lack of ceramics in the fill of this pithouse, indicates it is probably a very early Mesilla-phase structure. Its size is consistent with small Late Archaic and Mesilla phase pithouses. Structures 1 and 2 at Orogrande 1 are somewhat later, dating from the middle portion of the Mesilla phase. Although larger than Structure 1 at LA 115262, and larger than even the "large" Late Archaic pithouses at Keystone Dam, the Orogrande 1 structures are still well within the range of small, Mesilla-phase pithouses. As discussed in Chapter 3 (and see Whalen 1994a), Late Archaic pithouses tend to be smaller than their Mesilla-phase counterparts, this being the case for both small and large pithouse sites. Thus, temporal differences may help explain the size discrepancies between the Mesilla phase structures at LA 115262 and Orogrande 1, with both being "small" pithouse sites but anchored within different, evolving settlement systems.

Mesilla phase components were also identified at four other sites: LA 115256, LA 115259, LA 126181, and Orogrande North (LA 128708). None of these sites contained structures and their Mesilla-phase components yielded only thermal features and scattered, low-density artifact remains. Unless pithouses were present in uninvestigated areas, all of these are Class 4 sites in Whalen's (1994b) scheme, containing the remains of short-term and/or task-specific camps. Two of these sites are basin-floor localities (LA 115256, LA 115259), while LA 126181 and Orogrande North are both situated high on the bajada apron of the Jarilla Mountains.

The US 54 Mesilla-phase components all appear consistent with what we might expect from communities involving family/hamlet groups, or acephalous local groups, in Johnson and Earle's (1987) terminology (see Chapter 3). The excavation results suggest several general features of the subsistence, settlement, and social systems that operated among local Mesilla-phase groups. The presence of both small-pithouse sites and more ephemeral, structureless camps in basin-floor and bajada settings underscores a high degree of mobility and dispersion, and the exploitation of a diverse resource base. The result is a variety of settlement types in any given environmental zone. What remains unclear is the extent to which local Mesilla-phase groups were integrating agriculture into a subsistence economy that apparently still emphasized hunting and gathering. No cultigens were identified in the botanical remains from any of the US 54 Mesilla-phase components, although preservation conditions were generally poor at these sites. Lipid residues were recovered from some of the Mesilla-phase features (see Chapters 14, 16, and 28), but none of these yielded any residues that could be clearly associated with maize or other domesticated products. Agricultural production has been documented at some Mesilla-phase sites (such as Turquoise Ridge), and if the occupants of the US 54 sites were not engaged in horticulture, then this would indicate a notable degree of local subsistence variation within the region. On the other hand, it may be that horticultural activities were carried out elsewhere, and that maize or other domesticates



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were not transported to these sites, or simply did not preserve.

The dispersed, highly mobile settlement patterns of the Mesilla-phase components also suggest that population levels were sufficiently low so that relatively large group territories (allowing for extended seasonal mobility) could be maintained (see Chapter 3). Such conditions, in turn, suggest that sociopolitical relations were probably sufficiently flexible to allow for this degree of mobility, and seasonal aggregation and dispersion. Such a pattern is consistent with either the family/hamlet- or acephalous local group-levels of organization (Johnson and Earle 1987; see above). This seasonally mobile pattern probably encouraged a network of social and political contacts across a large area, through which information concerning resource availability was shared, and social interactions (including marriage arrangements, organization of communal feasts and rituals, exchange of food and other resources, etc.) could be maintained.

At any rate, the general sociopolitical *modus operandi* seems especially typical of prehistoric societies in the Southwest, where the modular assembling and disassembling of communities appears to have involved social units of varying scale, in a manner similar to the operation of sequential hierarchies (Johnson 1982, 1989; see Chapter 3). Sequential hierarchies tend to involve five or six decision-making units. Interestingly, at Orogrande 1 there are at least four structures that were occupied more-or-less contemporaneously, and more structures may have been present nearby, but outside the impact area. Still, the question remains how the small, middle Mesilla-phase group that occupied Orogrande 1 was linked to other groups in the area. That is, did they aggregate into larger base camps or villages (similar to Turquoise Ridge, Los Tules, and Conejo) at certain times of the year, or did they maintain a more dispersed settlement pattern, with aggregation perhaps occurring at specialized, communal-ceremonial facilities? These remain open questions and provide a compelling objective for future research in the area.

### *Late Formative*

The Late Formative period, which includes the Doña Ana and El Paso phases, was a time of substantial changes in the Jornada Mogollon region, with architectural trends featuring the appearance of room blocks at the beginning of the El Paso phase (see Chapter 3). At least five of the US 54 sites contained Late Formative remains (LA 6829, LA 115260, LA 115265, LA 126181, LA 128700), including 18 structures uncovered at the Jaca site (LA 6829). Of these 18 structures, 15 were pithouses, one was a surface post structure, and two appear to be connected within a room block. Within the series of 23 radiocarbon dates from Jaca, nine were from structures. The dates indicate a narrow time span ranging from the very late Doña Ana phase to the very early portion of the El Paso phase (see Chapter 6). Based on radiocarbon dates, stratigraphy, and ceramic assemblages, a three-phase sequence (Jaca I–III) was proposed for the Jaca site structures.

All but one of the Jaca site pithouses are simple, informal basins and pits. These include both rectangular and curvilinear plan shapes and cover a wide range in terms of floor area (see Table 31.2). The lack of daub or adobe indicates these simple pithouses sported superstructures of brush or other perishable material. Simple pithouses were constructed in all three of the Jaca site periods, and each of these periods includes simple pit structures in both the northern and southern clusters within the core area (see Chapter 6). The persistence of these two clusters throughout the occupational sequence at Jaca may indicate the maintenance of moieties within this settlement.

One formal pithouse, Structure 2, was uncovered at the Jaca site. It was larger in floor area than any of the simple pithouses excavated at the site and was distinguished further by having a plastered floor. This structure probably served as a ceremonial facility. Structure 2 appears to date from the late Doña Ana, Jaca I period. Other than the four main support posts (which were part of Structure 1 and may or not have been part of

**Table 31.2 Characteristics of Pithouses from the Jaca Site (LA 6829)**

| Structure | Floor Space ($m^2$) | Depth (>) (cm) | Hearth Type | Plastered Floor/Walls? | Internal Pits? |
|---|---|---|---|---|---|
| 2 | 11.6 | 20 | None | Yes | No |
| 5 | 10.4 | 40 | None | No | Yes (5) |
| 6 | 6.3 | 40 | None | No | No |
| 7 | 5.2 | 33 | None | No | Yes (1) |
| 8 | 5.9 | 6 | None | No | No |
| 9 | 2.7 | 10 | Informal | No | No |
| 10 | 1.9 | 26 | Informal | No | No |
| 11 | 2.2 | 19 | None | No | No |
| 12 | 1.7 | 20 | None | No | Yes (1) |
| 13 | 2.5 | 29 | None | No | No |
| 14 | 2.6 | 12 | None | No | No |
| 15 | 4.3 | 29 | Informal | No | No |
| 16 | 3.4 | 37 | None | No | No |
| 17 | 3.1 | 36 | None | No | No |
| 18 | Unknown | 10 | None | No | No |

Structure 2), no floor features were identified within Structure 2.

In terms of size, Structure 2 is quite small in comparison to most other presumed ceremonial structures of the late Mesilla and Doña Ana phases (Table 31.3). In fact, structure 2 is less than half the size of most of these other known special structures. Why this is so may relate to the fact that Jaca, at this time at least, was a settlement of simple, rather expediently built pithouses, whereas the other sites listed in Table 31.3 were made up of pit structures that were, for the most part, more substantially built. At Los Tules, most of the domestic structures were rectangular, set in fairly deep pits, and contained large support posts. One of these structures (House 11) had plastering on the pit walls. The domestic structures at Turquoise Ridge were, on average, similar in size to Structure 2 at Jaca and typically contained numerous postholes and substantial, sub-floor storage features. At Meyer and Hueco Tanks, the domestic structures exhibited an even greater architectural investment, with plastered floors, adobe walls, substantial support posts, and, at Hueco Tanks, the collared hearth/step arrangement.

The use life of Structure 2 ended when it was razed, filled in, and Structure 1 was built directly over it. Structure 1 consisted of a rectangular room covering nearly 30 $m^2$, which is well within the range of large, communal rooms within El Paso-phase pueblos. The floor of Structure 1 was plastered and it contained an assemblage of floor features and architectural characteristics that are typical of many El Paso-phase pueblo rooms. Specifically, Structure 1 has a long axis oriented east-west, contains an arrangement of four large support posts and a collared adobe hearth just north of the center of the south wall. Conspicuously lacking is the adobe step at this point in the south wall, but such features are not always present in El Paso-phase rooms. The two human interments within Structure 1, which were the only burials encountered at Jaca, further distinguish this as a special, probably communal, space.

Structure 1 may have been part of a linear room block conjoined to Structure 3, located immediately to the west. Structure 3 was identified only in the profile along the right-of-way edge, and so it cannot be confirmed that it indeed conjoined Structure 1. However, the adobe walls of Structure 3 appear to have been oriented east-west, in line with Structure 1. Moreover, its north-south dimension is slightly less than that of Structure 1, which is also consistent with El Paso-phase linear room blocks, in which the communal room tends to be larger than the other rooms.



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**Table 31.3 Presumed Ceremonial Structures of the Late Mesilla and Doña Ana Phases**

| Site | Structure(s) | Temporal Affiliation | Plan Shape(s) | Floor Area (m²) | Comments |
|---|---|---|---|---|---|
| Rincon | 4 | Late Mesilla | Round | 24.6 | Plastered hearth |
| Los Tules | 4, 5, & 6 | Late Mesilla | Round | 25.5–26.0 | Floors/walls not plastered. |
| Turquoise Ridge | 35 | Late Mesilla | Oval | ~ 30.0 | Only partially excavated. Perimeter bench; Few floor features; Floor/walls not plastered |
| Conejo | 3 | Late Mesilla | Round | 27.4 | Floors/walls not plastered. |
| Meyer | 3 | Late Doña Ana | Rectang. | 20 | Numerous floor features |
| Hueco Tanks | 6 | Late Doña Ana | Rectang. | 24.8 | Larger, and more carefully plastered floor, than other structures at the site, but contains milling bin suggesting domestic activities |
| Jaca | 2 | Late Doña Ana | Sub-rectang. | 11.6 | Plastered floor |

Thus, it appears almost certain that Structures 1 and 3 were conjoined. Interestingly, no additional rooms were identified on the east side of Structure 1, which would be somewhat unusual for an El Paso-phase room block, in that rooms are typically appended on either side of the large, communal room. This is not always the case, however; at Twelve Room House, for example, the largest room was situated at the east end of the pueblo (Moore 1947). It remains unknown whether or not additional rooms are present to the west of Structure 3 (this area, being outside of the right-of-way, was not investigated). It is possible that the Structure 1–3 room block was never completed and that this early attempt at pueblo construction was aborted for unknown reasons.

Structures 1 and 3 are dated to the Jaca II period, which appears to straddle the temporal boundary of the Doña Ana and El Paso phases. This is thus one of the earliest dated room blocks in the Jornada Mogollon region. Elsewhere on the site, simple, informal pithouses continued to be constructed and used during the Jaca II period. What this means in terms of social organization and community life within the Jaca settlement remains unclear, but at least two possibilities present themselves. First, assuming that the two spatial clusters of structures in the site core area indeed reflect a dualistic social division within this community, it is possible that only the residents within the northern division opted to construct a room block, while their neighbors to the south continued to live in pithouses. An alternative possibility is that the same individuals and families used both the room block and pithouses, according to functional and/or seasonal considerations.

By the Jaca III period, which covers the beginning of the El Paso phase, the Structure 1–3 room block appears to have been abandoned and the occupants of the site again lived exclusively in pithouses. Structure 1, the communal room, was dismantled and partially filled with trash, perhaps by occupants of the nearby pithouses, Structures 5 and 7. These are both roughly rectangular pithouses, and Structure 5 is the largest of the nonformal pithouses constructed at the site. Jaca III is the final site occupation episode documented.

The excavations at Jaca are especially noteworthy because of the high proportion of pithouses uncovered at this Late Formative site. Although pithouses were still the norm in the Doña Ana phase, and are certainly not unknown in the El Paso phase (e.g., O'Laughlin 2001a), it is the ephemeral character of the pithouses at Jaca that is really quite striking for such a late site. Late Doña Ana-phase pithouses tend to be substantial structures resembling pueblo rooms of the subsequent El Paso phase. In the latter phase most of the known architecture consists of pueblos or at least rectangular, stand-alone rooms. Most of the known El Paso-phase pithouses were excavated at the Firecracker Pueblo site (O'Laughlin 2001a), and the majority of these are substantial, rectangu-

lar structures. In contrast, with few exceptions the Jaca site structures were set in shallow pits that are oval, circular, or irregular in shape, and most lack internal postmolds and hearths. In most respects, their characteristics and sizes are much more similar to typical Mesilla-phase pithouses, and some early Doña Ana structures, than they are to later Doña Ana or, certainly, El Paso-phase houses. In fact, had the excavations at Jaca not produced so many decorated ceramics and consistent radiocarbon from these pithouses, they would probably have been identified as Mesilla-phase structures.

The presence of so many simple, informal pithouses in a late Doña Ana/El Paso phase settlement presents a picture of settlement patterns that is much more complex than what was known at the start of the US 54 project. According to the pithouse criteria identified by Diehl (1997), with the exception of Structure 2, the Jaca site pithouses score very low in term of architectural investment, and would indicate a seasonal, residentially mobile settlement pattern with only a moderate dependence on agriculture. Yet other evidence from Jaca, such as the botanical assemblages, indicate a substantial reliance on agriculture by the inhabitants of this site, with abundant maize remains recovered, along with lesser quantities of beans and gourd. Moreover, the presence of a formal pithouse (Structure 2) and the apparent coexistence of pithouses and a linear room block at one point in the settlement's history, paints a very complicated picture indeed—one that does not adhere to any straightforward settlement model. In these respects, the Jaca site seems to underscore Lightfoot and Jewett's (1986) conclusion that settlement systems involving pithouses were highly dynamic and varied in response to local conditions.

While the structures at Jaca are unusual for Late Formative settlements, the terrain location of the site is not. Situated at the foot of the Jarilla Mountains bajada, Jaca is in a classic location for Doña Ana- and El Paso-phase agricultural settlements. In fact, the bajada apron of the Jarillas appears to have hosted an especially dense concentration of Doña Ana-phase settlements (see Carmichael 1986:137). Given their intensified reliance on agricultural production, Late Formative peoples required a greater share of scarce water resources, and the concentration of precipitation runoff along, and immediately below, the alluvial fan surfaces made these localities especially favorable—and critical—for the primitive agricultural methods practiced at this time.

The same cannot be said for the Late Formative sites LA 115260 and LA 115265, which were both situated out on the desert floor. Although no structures were excavated at these sites, at LA 115260 two prepared, plastered floors were partially uncovered by machine excavations within the area between the two right-of-way fences (which was partially investigated during the data recovery phase; see Chapter 9). These remains probably mark the locations of substantial, Doña Ana-phase structures, although their character and dimensions could not be ascertained within the limited exposures in which they were observed. Nearby, within the 28-m right-of-way at this site, data recovery excavations documented a thick midden stain (Feature 1). A dense concentration of features was uncovered both beneath this midden and beyond the 28-m right-of-way immediately to the west. These remains indicate a substantial, intensive settlement, and the plastered floors apparently mark high-investment structures.

Although apparently covering a small area, the LA 115260 settlement may have been part of a dispersed community that included nearby site LA 115265. At the latter site, several features were uncovered including an intensely fire-reddened hearth with an associated concentration of ceramics and other artifacts. Although no structure remains were present here, this site had been severely impacted by previous construction of US 54, which may have obliterated any such remains, leaving only sub-floor features. Both LA 115260 and LA 115265 contain a ceramic assemblage containing decorated El Paso wares

but lacking Chupadero Black-on-white, indicating both sites probably date from the early Doña Ana phase.

LA 115260 and LA 115265 lie within a desert-floor playa. Here, the inhabitants of these sites were positioned to take advantage of any standing water that would have accumulated, and the elevated soil moisture that probably made agriculture a viable risk at this location. From the maize remains recovered at both of these sites, it appears that their inhabitants indeed practiced intensive agriculture. Still, this is an unusual location for Doña Ana-phase sites, which tend to be clustered along the basin edges and margins of the Jarilla Mountains bajada (cf. Carmichael 1986). The desert-floor context is especially unusual for Late Formative sites with evidence of substantial architecture. These two sites thus present a more complicated picture of Doña Ana-phase settlement patterns than current evidence would otherwise suggest. Given that these sites both appear to be *early* Doña Ana-phase components, it may be that settlement-subsistence patterns at this time still involved a more dispersed strategy similar to that of the preceding Mesilla phase, with agricultural fields scattered among desert-floor playas to take advantage of the hit-or-miss pattern of summer precipitation.

Substantial Late Formative components were also identified at Orogrande 2 (LA 128700) and LA 126181. Although no structure remains were encountered at either site, both sites produced thermal features, and LA 126181 also contained two discrete concentrations of broken ceramics and other debris. Unless structure remains were present outside the investigated areas, it appears that any houses or shelters constructed at these sites were probably ephemeral, light-duty constructions that did not leave any archaeological traces. Accordingly, the sites likely were occupied during the warmer months of the year. Unfortunately, preservation conditions at Orogrande 2 and LA 126181 were not especially good, and the botanical remains from these sites did not reveal much about seasonality or the kinds of subsistence activities carried out at these sites. But both appear to be small-scale camps, with a more restricted range of activities, than either Jaca, LA 115260, or LA 115265. Both Orogrande 2 and LA 126181 are situated on the bajada apron of the Jarilla Mountains, and indicate there was a variety of Doña Ana site types in this critical environmental zone. Orogrande 2, along with adjacent site Orogrande 1, are located at the juncture of two separate alluvial fans within the bajada. These sites were especially well positioned to take advantage of concentrated runoff from the mountains and converging bajada slopes.

Taken together, the Late Formative components documented during the US 54 project seem to highlight the unstable, dynamic tension between various forces that shaped the evolution of prehistoric Southwestern societies. These forces involved competing tendencies toward aggregation and dispersion, independence and interdependence, and coercion and resistance. In the central Jornada region, the extreme harshness of the local environment, and the continued emphasis on mobility options, served to limit the growth of communities and sociopolitical hierarchies—more so here than elsewhere in the late prehistoric Puebloan world. This intense ambivalence toward sedentism and life in closely-knit communities seems especially evident at the Jaca site; here, the evidence reflects a community apparently torn between a more mobile and independent life lived in simple pithouses, versus a more structured, communal mode embodied in linear adobe pueblos.

## Summary

Excavations along US 54 produced new data that are relevant to our understanding of variation in prehistoric houses and settlement patterns in the Jornada Mogollon region. The earliest structures documented in the Jornada Mogollon region date from the Late Archaic period. In the US 54 project, one Late Archaic structure was excavated—a Fresnal phase pithouse at Orogrande 1. Four



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Mesilla-phase structures were also exposed at Orogrande 1, and up to two pithouses from this phase were documented at LA 115262. The Late Archaic- and Mesilla-phase structures uncovered at these sites are both similar, in terms of size and architectural characteristics, to other pithouses known for these periods. The excavated Mesilla-phase structures at Orogrande 1 are larger than the one preserved pithouse at LA 115262, and the size differences may indicate a size dichotomy between large pithouse sites in basin-edge and bajada locations (Orogrande 1) and those out on the desert floor (LA 115262). Yet despite these size differences, all of the Mesilla-phase pithouses excavated in the US 54 project fall within the range of small pithouses for this time frame, as defined by Whalen, and the sample size from this project is too small to make definitive statements about pithouse size differences between these two sites. None of the other Late Archaic and Mesilla-phase components documented during the US 54 project contained preserved structure remains. Taken together, the Late Archaic and Mesilla-phase remains from the project are consistent with the prevailing picture of seasonal mobility, logistical resource procurement, and the construction of low-investment, simple pithouses.

For the Late Formative period, the US 54 findings produced a very mixed and interesting assortment of structures and settlement evidence. At LA 115260 and LA 115265, there is evidence for what may have been a single, early Doña Ana-phase settlement of spatially dispersed houses. Both sites probably contained substantial houses, with plastered floors partially uncovered at LA 115260, and what appear to be sub-floor features at LA 115265. These sites, both of which yielded maize remains, are situated in a desert-floor playa, an unusual location for Late Formative agricultural sites. At the Jaca site (LA 6829), we find a late Doña Ana/early El Paso-phase settlement where most of the occupation occurred in very simple, informal pithouses. Based on the pithouse alone, conventional wisdom would indicate this site was part of a highly mobile settlement pattern with little architectural investment in houses. This evidence is countered, however, by the presence of a formal pithouse, an apparent room block, and solid evidence for intensive agricultural production. The probable room block at Jaca represents one of the earliest attempts at pueblo construction in the central Jornada region. Finally, less intensive Doña Ana-phase encampments were documented at Orogrande 2 (LA 128700) and LA 126181, both of which are located on the alluvial fans of the Jarilla Mountains.

In social-evolutionary terms, the archaeological record from the US 54 investigations reflects both adaptation to a specific, local environment and on-going sociopolitical dynamics that tied local groups to each other, and to larger, regional networks. The harsh conditions of the local environment introduced severe constraints on scalar growth and evolutionary possibilities for prehistoric peoples in this area. Yet the area's inhabitants were never living in isolation; seasonal movements, residential mobility, and migration episodes kept populations in the Jornada Mogollon region in regular contact with each other and resulted in on-going cultural and genetic interaction. In this light, it is important to remember that settlement patterns in the area traversed by US 54 were shaped not only by local environmental factors, but also by broadly shared cultural-evolutionary forces and social-organizational tendencies that played out on this unique historical stage.



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Chapter 32

# A History of Orogrande and Mining in the Jarilla Mountains

*Jim A. Railey*

## Introduction

The railroad grade at LA 115258, and other historic archaeological remains in and around Orogrande, stand as mute testimony to a rich and colorful local history centered on mining activities in the nearby Jarilla Mountains (Figure 32.1). The shifting fortunes of the mining district (variously known as the Silver Hill, Jarilla, and Orogrande mining district) led the growth and demise of the associated settlements that came to be known as Orogrande, Brice, Ohaysi, and Lucky Flats. These local developments were spurred, in turn, by broader, regional and national trends including the fluctuating price of metals, changes in mining and processing technology, and the whims of history. To better understand the historic remains encountered by the US 54 project in and around Orogrande, it is necessary to view them in a local and regional context. The story is a familiar one among ghost towns of the American West. It is a story of discovery, investment by venture capitalists, and common people pursuing their hopes and dreams on a new frontier. Flourishing economic and social development defined Orogrande's boom period. High anxiety, behind-the-scenes intrigue, scandal, conflict, and violence marred local history during this period. In the end, disillusionment set in, followed by divestment and abandonment. Today, Orogrande retains only a shadow of its former glory, and the town's few inhabitants live among ruins and archaeological debris. A landscape reclaimed by the desert, along with a few surviving examples of architecture in Orogrande, are all that remain of what was once a vibrant, rambunctious, and turbulent period in the southern Tularosa Basin.

## Methods

This research began with an investigation of available archival records. Archival data were gathered at the New Mexico State Archives in Santa Fe, the University of New Mexico's Zimmerman Library in Albuquerque, the New Mexico Tech Library and New Mexico Bureau of Mines and Mineral Resources in Socorro, the University of Texas at El Paso Library (UTEP), and the Tularosa Basin Historical Society and Otero County Clerk's Office in Alamogordo. Table 32.1 presents a listing of archival resources obtained from the various repositories. Individuals knowledgeable about the history of Orogrande were also consulted personally. These individuals include Clif McDonald (Alamogordo resident who is the leading authority on Orogrande and has authored publications on the history of the town), William "Bill" Ward (Orogrande resident who conducts jeep tours of the town and mining district), and Peter Eidenbach (professional archaeologist based in High Rolls, New Mexico who commands an in-depth knowledge of local history). A search of the World Wide Web yielded the following sites with information on the history of Orogrande and mining in New Mexico: www.dei.net/epgpa/nm.htm; http://htg is.vianet.net/~artpike/brice1.htm; and www.ghosttowns.com/states/nm/orogrande.html.

## Geology and Mineral Deposits in the Jarilla Mountains

The Jarilla Range and its mineral wealth were formed through igneous intrusions and associated contact metamorphosis of preexisting limestone (Lasky and Wootton 1933:85–86; Schmidt and Craddock 1964; North 1982). During the upper Paleozoic (specifically, Devonian, Pennsylvanian,



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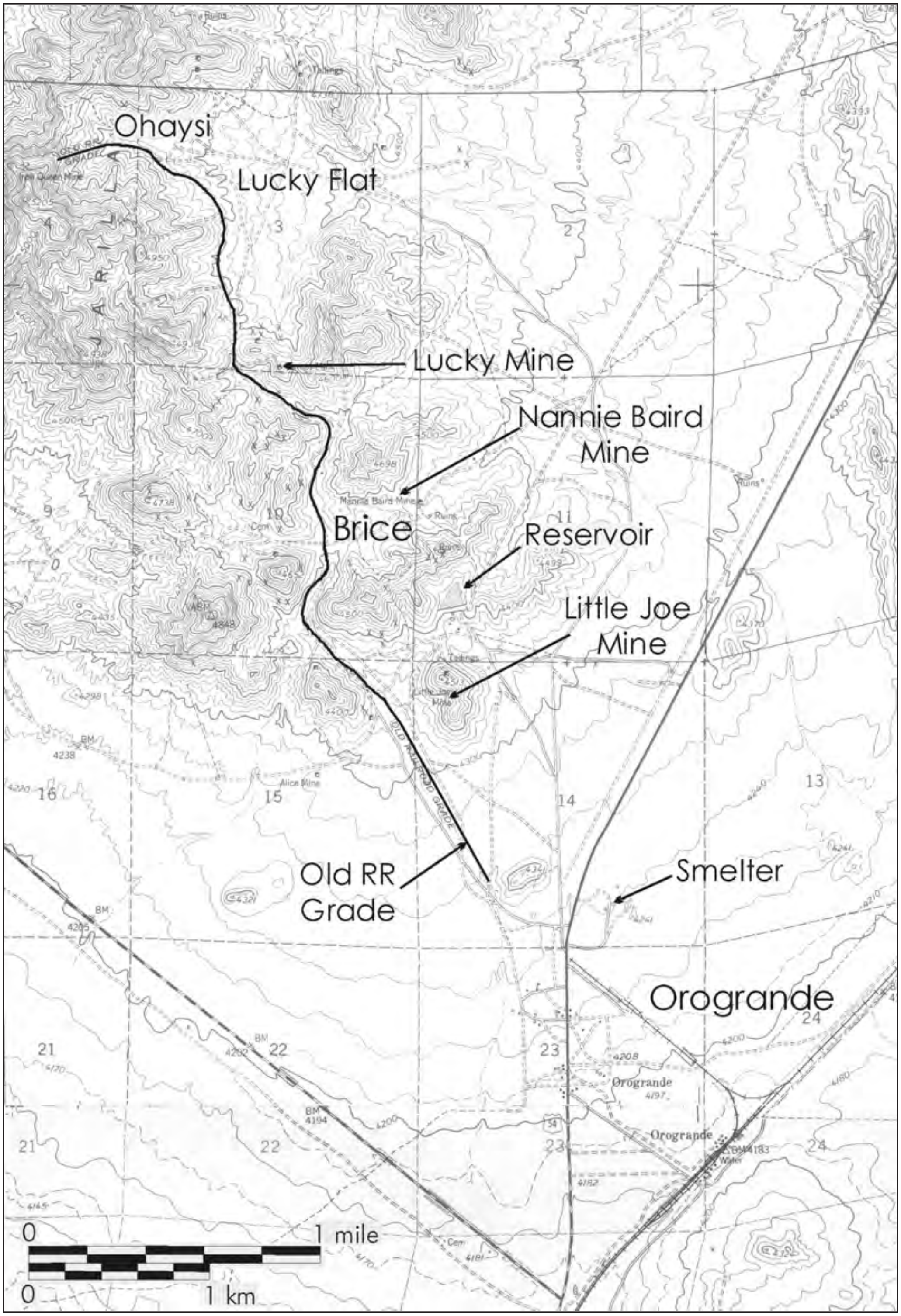


**Figure 32.1 Portions of Orogrande North and Orogrande South USGS 7.5' topographic maps, showing locations of places mentioned in this chapter.**



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**Table 32.1 Archival Resources Obtained on the History of Orogrande**

| Repository | Materials Obtained |
|---|---|
| New Mexico State Archives, Santa Fe | *Orogrande Times*, 1906–1907 (microfilm); various books & magazines |
| University of New Mexico, Zimmerman Library, Center for Southwestern Research, Albuquerque | *Orogrande Times*, 1906–1907 (microfilm); various books & magazines |
| New Mexico Tech Library, Socorro | USGS mining reports, 1905–23; NM School of Mines 1933 pub. re. metal resources of New Mexico |
| NM Bureau of Mines and Mineral Resources, Socorro | Open file report on the geology and mineral resources of the Jarilla Mountains (North 1982) |
| UTEP Library, Special Collections | Original correspondences relating to the acquisition of rights-of-way for the spur rail line from Orogrande into the Jarilla Mountains mining district |
| Tularosa Basin Historical Society, Alamogordo | Publications re. Orogrande's history; copies of correspondences & other documents |
| Otero County Clerk's Office, Alamogordo | Mining claims and property deeds |
| Mr. Clif McDonald (personal collections) | Historical photographs of Orogrande mining district; copies of newspaper and mining journal articles; miscellaneous documents |

and lower Permian times), marine ingressions into present-day southern New Mexico resulted in the deposition of thick layers of sedimentary rocks, including limestone, sandstone, shale, and arkose. Later, during Tertiary times, immense tectonic pressures produced upwellings of magma that intruded into the sedimentary strata.

The earliest of these igneous intrusions is marked by granodiorite and quartz latite formations. A later, much larger, igneous intrusion formed a suite of monzonite and quartz monzonite (the same rock type that forms the spectacular, saw-tooth formations along the crest of the nearby Organ Mountains). This intrusion resulted in considerable doming that contributed to the formation of the Jarilla Range. It is at the contact between the monzonite and limestone, a contact that occurred in a geologically shallow context (probably no more than 5,000 feet below the earth's surface at that time, and probably closer to 1,000 feet in depth [North 1982:10]), that metal ores formed through metamorphosis of the limestone. Subsequent pressures and cracking of the earth's crust at this point resulted in a series of dikes that cut through both the sedimentary and intrusive rocks.

There is appreciable mineralogical variation along the igneous-limestone contact, and the results of the consequent metamorphosis are likewise variable. Most notable are the contacts between the hornblende monzonite and the surrounding limestone, which produced mineralized (skarn) formations containing the best grade ores of copper, gold, silver, lead, and iron. The ores themselves were deposited within fractures and along bedding planes of the original limestone. Within the monzonite, highly localized alteration resulted in the formation of turquoise veinlets, with the turquoise weathering out as small nuggets.

The nature of the monzonitic intrusion (i.e., probably involving lower temperatures than the earlier granodiorite intrusion) was such that relatively narrow skarns were formed at the contact. Silicate intrusions into the limestone, within which the economic ores formed, extend no more than 60 feet from the irregular monzonite contact, and the deposition of metal ores within fractures, and along bedding planes, means that they are highly localized in occurrence. The distribution of these vein-like deposits along the narrow contact, not to mention the irregular upper surface of the monzonite dome, are primarily responsible for the random occurrences of these lode formations. Because of the zoning of these mineralized deposits, most of the accessible gold and copper

occurs in the central and southern portion of the Jarillas, in the vicinity of Brice and Lucky mine, while iron ores are more plentiful to the northwest, around Ohaysi and Lucky Flats (North 1982:11). The iron is a high-sulphur grade that was used heavily in the past but today has little economic potential (North 1982:12).

Ongoing erosion of the Jarilla Range also resulted in the deposition of placer gold in the bajada apron along the southeastern margin of the Jarilla Range, northwest of the town of Orogrande. Because of the thickness of this alluvial fan, placer gold mining here has involved both surface and shaft operations, although most placer gold in this locality reportedly occurs near the surface (Johnson 1972; North 1982:8). Moreover, these deposits yield relatively small quantities of placer gold, and mining activities quickly depleted these deposits. For some years now, placer gold mining has been largely a recreational, rather than economic, pursuit, although some patented claims are still maintained.

## Orogrande and Its Mining District: A Saga of Boom and Bust

Mining activities in the Jarilla Mountains began in prehistoric times. Local Native Americans worked the range's turquoise source, digging shallow pits to obtain this sacred stone (Jones 1904:194; North 1982:3). These prehistoric turquoise mines were rediscovered in the early 1890s (Hidden 1893). The semiprecious stone attracted the attention of Tiffany Jewelers of New York. Later, the deposits were worked by a dealer in turquoise and precious stones named Amos J. De Meules (Figure 32.2). De Meules was murdered in 1898 (North 1982:2; Comer 1997:17, reports he was murdered in 1904, but this appears to be incorrect). Economic turquoise mining in the Jarillas slowed considerably at this time, although smaller scale turquoise collecting (largely recreational) continues here to the present (North 1982:2). The history of turquoise mining was briefly summarized in the December 12, 1912 issue of the *El Paso Herald*:

> The Jarillas were worked hundreds of years ago by the Zuni Indians for turquois and gold, as evidenced by ancient workings and a deserted village to the west, where fragments of pottery are found. The Tiffanies, of New York, did some exploration work on the turquois veins some 20 years ago. Subsequently, Amos J. DeMuels "the hermit of the Jarillas," located and worked the turquois mines. He found a ready market for the gems, and realized over $50,000 up to the time of his murder by a Mexican employe about 12 years ago. Afterwards, Pat A. Kelly, Thos. A. Kelly and Christ Yeager worked the turquois mine and extracted about $50,000 worth of gems.

The earliest reported prospecting of metal ores in the Jarilla Mountains began in 1879 by S.M. Perkins, or "Ole Perk" (Jones 1904:194; McDonald 1998:40; Sherman and Sherman 1975:21; the name is reported as "J.M. Perkins" by North [1982:2]). During his prospecting in the Jarillas, Perkins reportedly once stumbled upon a camp of Mescalero Apaches, who nearly killed him until they observed he was slightly hunchbacked and spared his life out of a cultural proscription against killing deformed individuals. Perkins continued to prospect, and among his discoveries was the Nannie Baird mine, which eventually became one of the most productive mines in the Jarilla District. In 1883 Perkins was reportedly "camped on his claims. As he is far away from civilization, he is happy" (*Rio Grande Republican*, June 16, 1883).

Soon after prospecting in the Jarillas began, several small mining operations and associated settlements were established in the district. By 1883, the district was abuzz with mining activity, with several shallow shafts (up to 50-feet deep) sunk into ore outcrops (*Rio Grande Republican*, June



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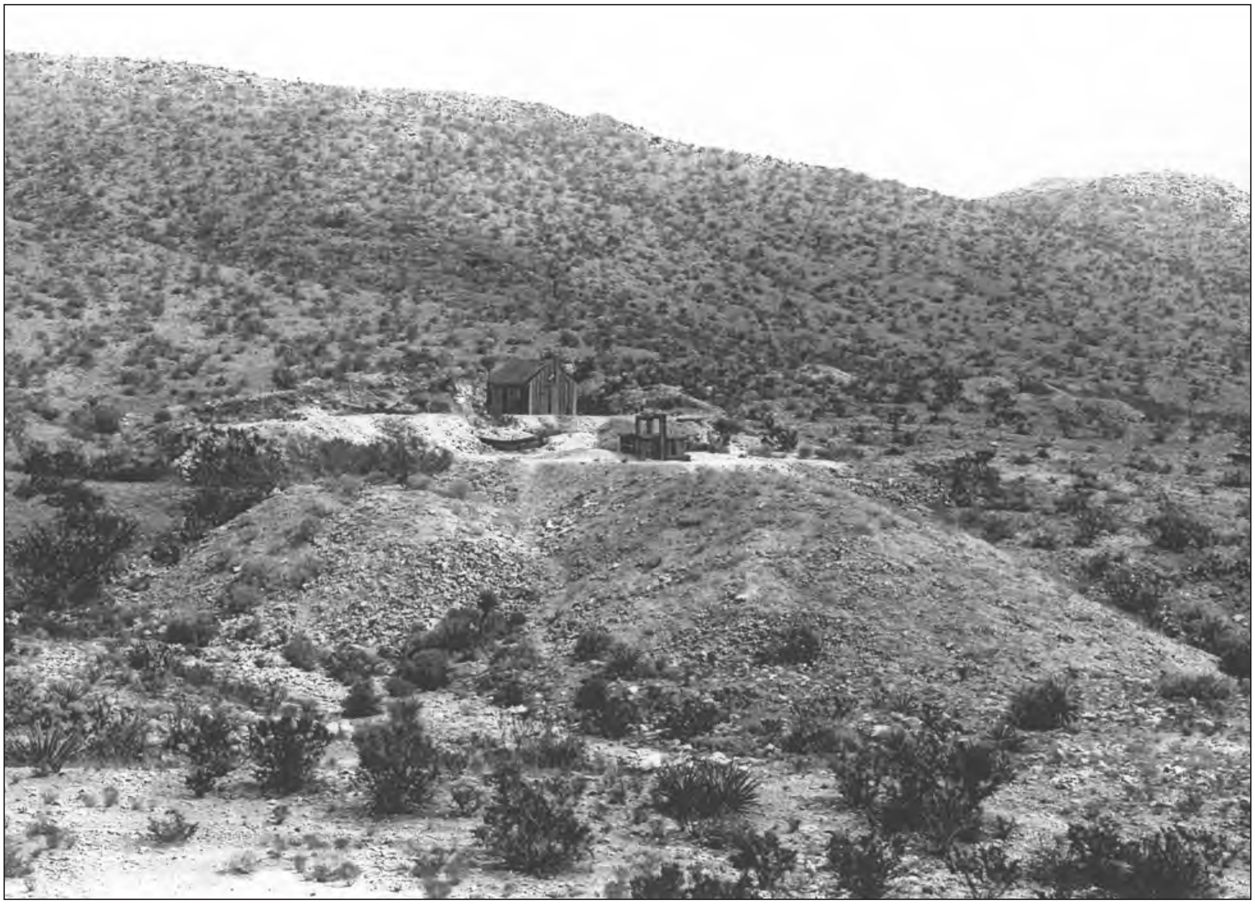

**Figure 32.2 The DeMeules turquoise mine, looking north. Photo taken July 1913, more than a decade after DeMeules' death (Courtesy of Rio Grande Historical Collections/ Hobson-Huntsinger University Archives, New Mexico State University).**

16, 1883; North 1982:2). The output from these initial mining activities led to great interest in the Jarilla District by prospectors and mining companies. Some of the companies were established specifically to tap the anticipated mineral wealth of the Jarillas. Besides turquoise, early mining efforts focused on gold, copper, and silver; iron mining would gear up later. Mining involved both underground (i.e., drift) and placer operations. Placer operations included the Little Joe Placer mine, owned by the Electric Mining and Milling Company, which utilized a dry washer to recover the placer. The prevailing expectation was that a bonanza of mineral wealth was waiting to be tapped. Plans at this time to build a rail line through the area (*El Paso Herald*, March 25, 1903) further spurred interest and development. This brought an influx of investors, prospectors, and workers. Due to the business failure of an early railroad construction venture, however, the railroad did not actually arrive until 1898.

The early years of mining in the Jarillas illustrate typical frontier conditions. A eulogy to the murdered miner, DeMeules, described some of the uncertainties, hardships, and conflicts he experienced. These difficulties must have been common in the raucous, early days of mining activity in the district.

> After several years hard work and weary waiting success came to him, as the advent of the railroad



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> hastened it when success crowned his efforts. Some of those who had jeered him and looked upon him as partially demented, became envious of him, and attempted to filch his success by jumping some of the claims he had held on to for years when he was able only to keep up his title as required by law. Not being a coward, he resisted their encroachments and drove the trespassers off, when they tried to accomplish their purpose by forcing him into court on a trumped up charge that he had driven them from the public domain. The charge fell to the ground, although it cost him several thousand dollars of money that had come to him through such hard labor. Not daunted by the bitterest opposition he continued his development with varying success until he was cowardly assassinated and others reaped the results of his deprivation and labor, as has generally been the case with the hardy pioneer (*El Paso Herald*, October 24, 1907).

By 1890, attempts were made to impose more lawful order to property rights claims in the Jarillas. On March 13 of that year, the Jarilla Mining Company filed the first patented claim in the district on their Grizzly Bear mine (Comer 1997:17). Subsequent claims (33 in total) were patented between 1890 and 1926 (Comer 1997:17; North 1982:3).

Along with the mines, small settlements sprang up that eventually came to be known as Brice, Ohaysi (also spelled *Ohayse* [Townsend and McDonald 1998:89] and *Ohace* [Townsend 1998: III), Zora, and Lucky Flats. (Townsend and McDonald [1998:89] report that Zora was another name for Ohaysi; North [1982:Figure 2] shows Zora located northwest of Ohaysi.) These were mostly tent settlements at first; more permanent structures were erected later. Early accounts refer to the "camp" of *Jarilla*, but it is not always clear to which of the settlements these accounts refer (i.e., those eventually named Brice, Ohaysi, Lucky Flat, and Orogrande), or if the scattered tent settlements in the area were collectively known as "Jarilla Camp." Brice was originally known as *Jarilla* (Sherman and Sherman 1975:21; Webb 1982); its name changed in 1904 (Sherman and Sherman 1975:21). Similarly, present-day Orogrande was also referred to as Jarilla, and become known as *Jarilla Junction* once the rail line and train depot were built there in 1898. It is unclear to what extent there was a settlement at present-day Orogrande before the railroad arrived in 1898. The fact that the earliest school and post office were established at Brice suggests its historical precedence over Orogrande. At any rate, it appears that, at first, most of the area's population was settled among the mining operations themselves, in the mountains (where the lode mines were) and on the bajada slope draping the southeast flank of the Jarillas (where placer mining was carried out).

The main limitation to mining at this time was the lack of water, which quickly became a valuable commodity in the Jarilla mining district. Among the early infrastructure projects in the area was digging earthen tanks for collecting rainwater.

> Mr. Lamot has bought a half interest in Mr. Hart's tanks for $1000. As the rainy season is coming on, and there is a great deal of work to be done this year, this should prove a good investment. Water can be sold at $3 a barrel, and the tanks are estimated to hold in the neighborhood of 3000 barrels. Should only 1000 [be] caught this year, there would be a good profit on the money (*Rio Grande Republican*, June 16, 1883).

It does not appear, however, that the earthen tanks proved to be a reliable water source.

S.M. Perkins reportedly had an earthen tank, but it went dry, prompting him to trade the Nannie Baird Mine for two barrels of drinking water (Sherman and Sherman 1975:21). Wells were drilled, but were usually either dry or yielded water that was so alkaline as to be unusable (McDonald 1998:33–34; Townsend and McDonald 1998:84). A curious exception is a 1907 report of usable water encountered in a mine shaft.

> The lack of water in this camp has been a great hindrance for the past several years, but now plenty of water is being encountered at a depth of 200 to 300 feet and it is thought the water question is practically settled. The Valley shaft alone is now producing about 75,000 gallons per 24 hours (*Western Mining World*, August 18, 1907, p. 251).

Apart from such isolated successes in finding potable water, the unreliability of earthen tanks and wells in the Jarillas forced the district in its early years to haul water by wagon from El Paso. The $3/barrel price for water was roughly equal to a miner's daily wage (Townsend and McDonald 1998:84).

The water problem highlights another obstacle plaguing the earliest mining operations in the Jarillas, namely, transportation. Ore had to be hauled out by horse-drawn wagons, and supplies hauled in the same way. Most wagonloads at this time ran between Jarilla and El Paso, where smelters constructed in 1887 and 1888 were the destination for Jarilla Mountain ores. A thriving western town at this time, El Paso was the main source for food and supplies, including the desperately needed barrels of water. Since the distance, time, and logistics involved in transporting ores and supplies by wagonload between Jarilla and El Paso cut into profits, there was a great incentive to improve the transportation infrastructure (Charles 1966:15).

Mining prospects in the Jarillas received a considerable boost at the end of the nineteenth century, when the railway and associated facilities finally arrived. The El Paso and Northeastern Railroad line was laid through the Tularosa Valley in 1898 (Townsend and McDonald 1998:4). This line ran from El Paso northward to White Oaks, New Mexico, and was often referred to in the early days as the El Paso to White Oaks line or, simply, the White Oaks line. Plans for constructing this rail line were in place by the early 1880s. The new line would connect the Southern Pacific line with the Rock Island lines, strengthening El Paso's position as an important transportation and supply center in the Southwest. A group of El Paso investors, led by Morris R. Locke, acquired the franchise to build this line in 1888, but they went broke before the tracks even reached the New Mexico territorial line. Another attempt to construct the line failed in the early 1890s when Jay Gould, who purchased the franchise from the Locke group's receiver, died before construction began. The city of El Paso then gained control of the franchise and in 1897 opened bidding on the project. Coming out on top of the intense bidding competition was a team consisting of the Eddy Brothers (Charles Bishop and John Arthur) and their attorney, William Ashton. These three men were the founders of the city of Alamogordo. The Eddy Brothers had an acute interest in the construction of the rail line, as they were already invested in Jarilla District mining activities (Townsend and McDonald 1998:85).

A train depot was constructed at present-day Orogrande in 1898 or 1899 to serve the local mining district. (Sherman and Sherman [1975:166] report the construction of the depot as 1897, although this date is incorrect as the rail line itself did not arrive until the following year.) The rapidly-growing settlement assumed the name Jarilla Junction at this time. The train depot (Figure 32.3) soon became a center for social activities including dances and club meetings (McDonald 1998:34). More importantly, the rail line and depot eliminated the long, expensive, and cumbersome process of hauling ores to, and supplies from, El Paso by wagon. The line also resulted in increased supplies of water, which now arrived by



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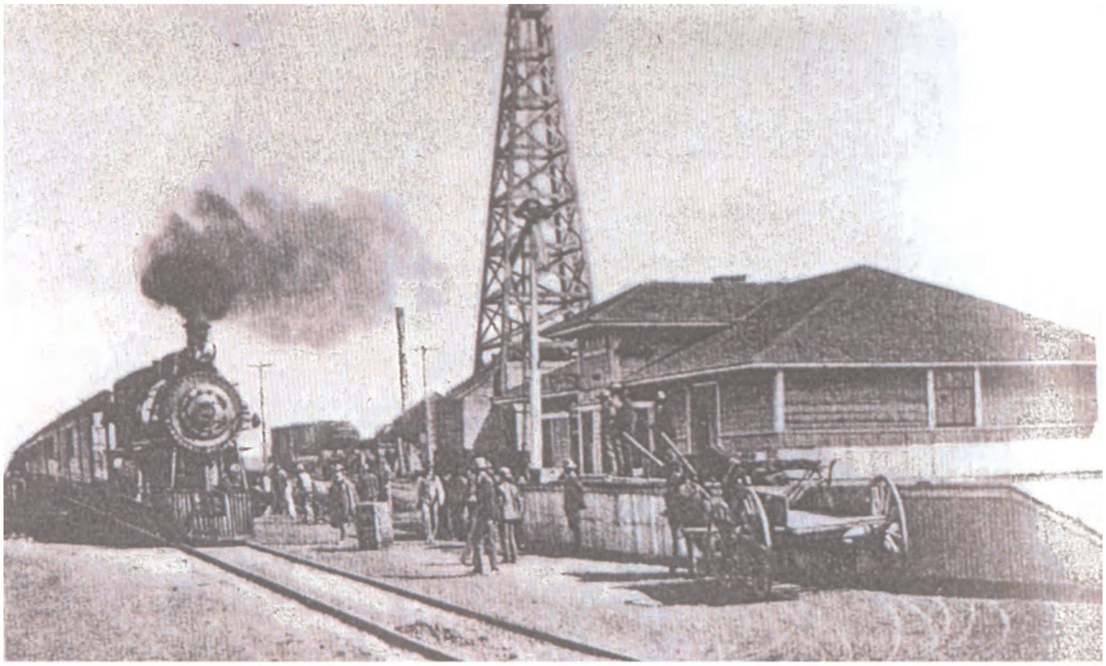

**Figure 32.3** **The Jarilla Junction/Orogrande train depot. Top: 1904 photograph of the depot. Bottom: 2001 photograph of depot site (top photograph courtesy of Rio Grande Historical Collections/Hobson-Huntsinger University Archives, New Mexico State University; bottom photograph by Jim A. Railey/TRC).**

the tank load, via the train (*El Paso Herald*, July 5, 1899). The faster and cheaper transportation provided by the railway stimulated investment, development, and population growth in the Jarilla district (whose population was reported as 300 in 1898 [*Engineering & Mining Journal* March 25, 1898]). Development plans for Jarilla Junction accelerated, along with investment in real estate and businesses to support the mining community. An article about Jarilla Junction, entitled "Progress Steady—A Town Will Be Built Before Long—Cottages To Be Erected—A Hotel Needed—Personal Notes," appeared in the July 17, 1899 issue of the *El Paso Herald*. It reported the following:

- Al Culver of El Paso has purchased two lots and is pushing to completion a frame building 34 x 50 to be used as a short order restaurant and saloon.
- W. Pendergrass has purchased a lot adjoining the camp depot and moved his saloon building onto it, so now the lovers of cold beer can get it without walking a mile from camp.
- The Alamogordo Improvement company, owner of the camp town site, are now selling lots, and in a short time we will step out of our swaddling clothes of flopping falling tents, into more comfortable frame buildings, when we can say to El Pasoans and others, come on, we can give you accommodation while you take in the wonders of the greatest mining camp of all New Mexico and the southwest.

In 1899, the El Paso and Northeastern Railroad built a spur line, the Jarilla Branch, from Jarilla Junction to the Lucky Mine (*El Paso Herald*, March 20, 1899; Myrick 1970:100). This, now abandoned, spur line includes the present-day archaeological site LA 115258. The railroad spur enhanced development and mining activities in the Jarilla Mountains. In 1899, a post office was opened at Jarilla (later known as Brice). By 1905 plans were underway to extend the spur line to Ohaysi (*Western Mining World*, November 11, 1905). This extension was not completed until 1916. A cut through the mountains was opened up to provide access from Brice to Ohaysi. This thoroughfare was traversed by wagons until the rail line came through a decade later. To facilitate transport from Ohaysi to Orogrande, the Lucky Mine opened a shaft tunnel through the mountain in 1907 and ran horse-drawn carloads of ore to the head of the main spur line (Figure 32.4). There, loads were dumped into the waiting train cars through holes cut in a bridge that stood above the tracks. This bridge still stands today (Figure 32.5). The "tolls" charged for use of the tunnel augmented the Lucky Mine's profits, and its strategic location (along with its volume of ore production) solidified its position as one of the most profitable mines in the district.

Although it was an infrastructure boon to the mining district, the spur line became a financial burden to the El Paso & Northeastern Railroad.

> For some time, there has been a rumor current that the El Paso & Northeastern company would take up the Jarilla branch of the line as it is being operated at a loss to the company. If this were done it would be a death blow to that camp and the officials of the line fully understand this and have given out that the line is not to be taken up but will continue to be operated as in the past (*El Paso Herald*, May 1, 1903).

It is not clear what sort of arrangements were made to keep the spur line in operation, but it is likely that the Eddy Brothers had some hand in this, as they were among the more prominent investors in the Jarilla District mines. They, along with several other groups, provided a large infusion of capital into the mining district.

> The principal holdings in the camp are Eddy Brothers', a group of 30 claims; the St. Louis United Copper Company, composed of



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**Figure 32.4 Mule-drawn carload of ore being hauled through a mine tunnel (probably the Lucky Mountain tunnel). Early-twentieth century, precise date of photo unknown. (Courtesy of Clif McDonald.)**

> prominent stockholders of the Granite Bi-Metallic Company, a group of 9 claims; the Jarilla Copper Company, composed of Philadelphia parties, 4 claims; the Jarilla Gold Mines Company, composed of El Paso and Boston parties, 10 claims; the Organ Mining Company, composed of El Paso and Denver parties, 10 claims, and heirs of the late A. J. DeMoles [i.e., De Meules], 8 claims. Many prospectors and private speculators hold claims and fractions, that are changing hands at from $500 to $3,000 per claim according to location and showing, while in one case $10,000 has been offered and refused for a half claim which is particularly well located (*Engineering & Mining Journal*, March 25, 1898).

Along with the railroad, investment and mining activity in the Jarilla district was stimulated by almost continuous reports of new placer strikes and stunning production figures between 1899 and 1903. Table 32.2 provides a sample of headlines from this period in the *El Paso Herald*.

Several columns by A. W. Gifford published in 1899 issues of the *Herald*, admonished El Pasoans for missing out on the opportunity for substantial profit in the Jarilla district, and warned that the time to get in on good investments was rapidly running out.

The bout of "gold fever" experienced in the Jarilla Mining District over these years also reportedly involved incidents of fraud. There are doubts about the published production and value figures, and some of the discoveries in the district, along with the likelihood that not all extracted ores were officially reported (Comer 1998:19). There are also reports of outright deception by some seeking to attract investment.

> An old-timer recalls that placer gold was "planted" in specific spots and that pans were supplied for the gullible gold seekers to pan a sample of gold for themselves. One old-timer remembers that a promoter put gold dust into a shot gun shell and fired it at the face of a rocky cliff, then showed a gold seeker there was gold there (Jeness 1964:3).



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**Figure 32.5** Top: overview of the Lucky Mine area and the bridge constructed over the spur rail line, from which ores were dumped into waiting train cars. Bottom: close-up of bridge. This was the terminus of the spur line until it was extended to Ohaysi in 1916. Photographs by Jim A. Railey/TRC, June 2001.

**Table 32.2 Selected Headlines from the *El Paso Herald,* 1899–1903**

| Date | Headline |
|---|---|
| 7/5/1899 | A Handful of Gold Dust. Exhibited This Morning in the Herald Office. Rich Placer Mine |
| 7/11/1899 | A Second Klondike |
| 7/14/1899 | Gold Nuggets |
| 8/10/1899 | Mountain of Lead. Said To Have Been Discovered in the Jarillas |
| 9/23/1899 | The Richest Yet. Dirt Struck in the Jarilla Placers That Yields $100 To The Yard |
| 11/6/1899 | Nuggest from the Jarillas. One Weeks Clean Up at the “Little Joe” Yielded $700 of Virgin Gold. |
| 7/30/1901 | Big Strike at Jarilla. The Silver Leads Have Been Struck, and They Are Rich |
| 1/29/1902 | A New Mining Strike |
| 2/12/1902 | Jarilla Camp Gold Strike. Several Big Veins Panning High Values—Jarilla Copper Company Will Spend A Quarter Of A Million in Developing Their Properties |
| 7/25/1903 | Sulphuric Acid in the Jarillas |

> When the big promotion was on at Orogrande in 1906, Bess Voorhees told her father, H.T. Martin, how she made $14 in one day at the real estate office which had 16 employees! After a few questions, he decided the mines were salted and he made her resign—the Eastern speculators were being “taken” as their options expired in 30 days (Charles 1966:16).

Such dubious practices, along with the uneven occurrences of the metal ores themselves, made investment in the Jarilla Mining District a risky proposition. Some speculators reportedly earned “as much as 4,000 per cent return on their investment while others never got their seed money back” (Townsend and McDonald 1998:85).

The years 1904 and 1905 proved to be pivotal for the history and development of the Jarilla Mining District, and the settlement that would soon become known as Orogrande. In June 1904, a 6.5-oz. gold nugget (about the size of an adult’s finger) was discovered during a dry washing operation on the Electric Mining and Milling Company’s Little Joe Claim (Jenness 1964:2; North 1982:3). The operator of the Little Joe mine was George E. Moffett, a mining engineer who served as the Justice of the Peace for Orogrande and, later, an Otero County delegate to the 1910 New Mexico Constitutional Convention (McDonald 1998:41; Townsend and McDonald 1998:89). Interestingly, the famous nugget at the Little Joe just happened to be discovered while a group of investors were looking on. The person who was operating the washer and recovered the nugget was Bob Raley (Figure 32.6), who is one of the more noted personalities in the area’s history (more on Raley below). It was the largest piece of gold that had been recovered in the Jarillas to date, and a newspaper writer at the time reportedly dubbed it “oro grande,” or big gold (Jeness 1964:2; North 1982:3). This discovery intensified interest in the Jarilla Mining District, and Jarilla Junction quickly became a boomtown.

The Orogrande boom was also due in no small measure to the development activities of the Southwestern Smelting and Refining Company (SWS&R Co.). Organized under New Mexico territorial laws on December 5, 1904, the SWS&R opened with offices at Jarilla Junction and St. Louis (North 1982:3). Initially, the company’s main objective was to build a smelter. However, the company later acquired mining claims (*Mining Reporter,* September 28, 1905; North 1982:3) and constructed a water pipeline to the Sacramento River, some 30 miles east of Orogrande. Completed in 1906 (*Orogrande Times*, May 3, 1905), the pipeline delivered approximately 50,000 gallons/day, and provided a source for desperately needed water, one that was


**Figure 32.6 Bob Raley operating a dry wash machine at the Little Joe Mine, while potential investors look on, June 1904. It was on this day the 6.5-oz. gold nugget, that supposedly was the namesake for Orogrande, was discovered (courtesy of Rio Grande Historical Collections, New Mexico State University, RG 97-25).**

more reliable and economical than hauling barrels of water by wagon or rail. The pipeline ran up into the Jarillas, where it filled a reservoir at Brice (see Figure 32.1) and, among other uses, provided a ready water supply for the placer operations on the bajada below. Cottonwood trees were planted around the reservoir, and it became a favorite spot for family picnics and other outings. Upon completion, the pipeline brought further interest in investment and development in the Jarilla Mining District. The pipeline is still in use today, continuing to provide water to Orogrande.

Meanwhile, the settlement of Jarilla Junction grew rapidly in population, services, and business establishments. A post office was opened in 1905 (Townsend and McDonald 1998:84), and the name of the town was officially changed from Jarilla Junction to Orogrande on April 2, 1906 (*Orogrande Times*, April 5, 1906). A newspaper, the *Orogrande Times*, was published and ran for two years, 1906–1907. By the beginning of 1906, the town had approximately 500 residents (*Orogrande Times*, January 25, 1906). Nearly two years later, the town had grown to approximately 1,200 (*Orogrande Times*, December 21, 1907). Others put the peak population of Orogrande at 2,000–3,000, presumably referring to this same period (e.g., Charles 1966:16; McDonald 1998:33; Townsend and McDonald 1998:84). By any account, Orogrande was now



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the preeminent settlement in the district; Brice in 1905 had a reported population of 150 (Sherman and Sherman 1975:21).

Building activity within Orogrande could hardly keep pace with the influx of new residents during the first decades of the twentieth century, and real estate investment and development flourished (Figure 32.7). Frame buildings, both homes and business establishments, sprang up in Orogrande and Brice. Among the new establishments in Orogrande were hotels, saloons, real estate offices, supply houses, and brothels (but no churches). Lodging options included motel-like tent facilities (Figure 32.8), and the soaring demand for housing led to creative business operations and some social tensions.

> The town reached a population of two thousand residents, gold seekers and promoters. Real estate offices opened, and the area became so over-populated that many prospectors and promoters lived in tents and shacks, both in the town and in the mountains. Sixteen tents of three beds each dotted the settlement, and nine saloons kept the residents in a state of nervous tension resulting in fights and many kinds of crimes. … (O)ne woman resident rented tents for sleeping quarters in addition to running a boarding house, and rented the same beds to both day and night mine-workers, without regular changes of linen, and without the knowledge of either group. One night-worker, coming off duty early one morning found his bed occupied and was told that it had been rented alternately to both shifts for the past six months. Getting no satisfaction after strong remonstrance against the double deal, the angry miner pulled a gun and shot the occupant of his bed to death (Jenness 1964:3, quoting oral accounts by Harry A. and Bess Voorhees).

In 1905, in an attempt to impose some order on what was a ramshackle tent camp, a blueprint map showing the town's layout was produced by the SWS&R Co (Figure 32.9). This map featured a square-mile grid of named streets (unpaved) and even a city park in the southeastern portion of the town (Jeness 1964:3). The grid reportedly contained five thousand lots; many of these lots were sold between 1905 and 1909 (Jeness 1964:3). Woodson Street was the main thoroughfare (Figure 32.10); the heart of the small business district centered at Woodson and Gordan Street (William Ward, personal communication 2001). Beginning in 1906, the Croteau building on Woodson served as a temporary school for local children (*Orogrande Times,* September 27, 1906) until a permanent school building was constructed, which opened the following March (*Orogrande Times,* March 7, 1907). Desert vegetation and coppice dunes have now reclaimed this once bustling street (and much of the rest of Orogrande). The clamor of business activity along Woodson Avenue left a high density of archaeological debris including cans, bottles, and other debris (Figure 32.11).

Brice continued to develop as well, helped in no small part by the spur railroad line that facilitated the transport of hardware and other building supplies to the town. In 1904, a Boston promoter promised funds for a school if the community would agree to change its name from Jarilla to his surname, Brice (Jeness 1964:3). By 1905, Brice hosted not only the first schoolhouse in the mining district, but also had a saloon, hotel, general store, and the offices of four mining companies, as well as the mine facilities themselves (Sherman and Sherman 1975:21). The school building was two-storied, constructed of locally manufactured cement blocks. This facility included accommodated grades 1–12 (Figures 32.12 and 32.13). Although some frame houses were constructed, many of the residents of Brice and the other mining settlements in the mountains continued to live



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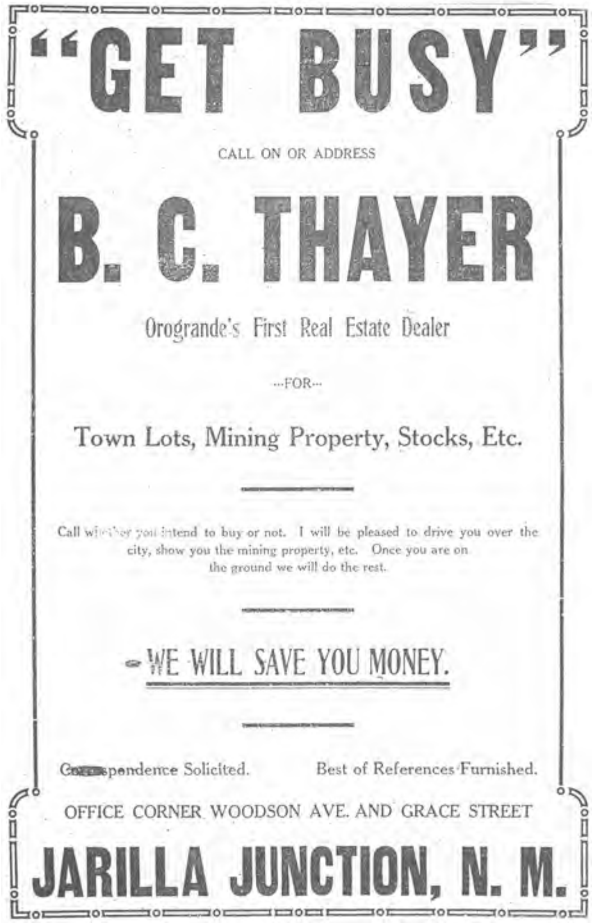


**Figure 32.7 Real estate advertisement that appeared in the first issue of the *Orogrande Times,* January 18, 1906.**


**Figure 32.8 1906 photograph of E.M. Abbott's "tent hotel" and general store in Orogrande.**


**Figure 32.9 1905 blueprint map showing the proposed layout of streets and lots in Orogrande.**

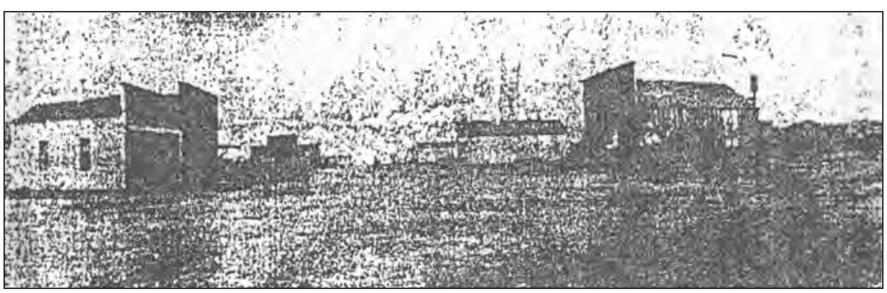

**Figure 32.10 Photograph of a street scene in Orogrande, that appeared on the front page of the November 1, 1906 issue of the *Orogrande Times*. These buildings were probably located along Woodson Avenue, which was the main business strip in the town.**


Figure 32.11 Woodson Avenue, once the business center of Orogrande, as it appears today. Top: corner of Woodson and Gordan, one of the main business intersections. Bottom: early-twentieth-century cans and other debris along Woodson Avenue (Jim Raily/TRC 2001).



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**Figure 32.12 The Brice school house. Top: drawing of school house based on a 1923 photograph in Webb (1982). Bottom: Class of 1923 at the Brice School (from Webb 1982:xvi).**



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Figure 32.13 The remains of the Brice School today. William Ward appears in the upper photograph (Jim A. Railey/TRC 2001).

in tents or "dugouts," which were shack-like pit shelters covered by either canvas or metal roofing. Some dugouts were lined with rocks or concrete. Today the dugouts are marked by pit-like depressions and other remains associated with these dwellings (Figure 32.14). The remains of two mine facilities still stand in the Brice area; one is the main office building for the Nannie Baird mine, and the other is the brick powder shed (Figure 32.15). There is also a cemetery west of the main settlement. Today a wooden cross, erected long after Brice was abandoned, marks the cemetery; there are no surface indications of individual graves.

Despite the giddy optimism that permeated news reports of the Orogrande area at this time, all was not well with its various business ventures. Consider SWS&R Co.'s smelter project, which was to provide a local destination for ores extracted from the nearby mines. The construction of the smelter created tremendous anticipation and anxiety for Orogrande. This project was plagued by repeated delays in completing and bringing the smelter into operation, as seen in a sampling of headlines from 1906–1907 issues of the *Orogrande Times* (Table 32.3). It is not clear to what extent the unexpected delays exacerbated social tensions within the rapidly growing town of Orogrande. One report stated that the smelter intended to employ 200 men (*Western Mining World*, July 7, 1905), but a later article reported an anticipated work force of 60 (*Western Mining World*, November 15, 1907). Problems surrounding the smelter construction are not easy to discern from reading the local newspaper. The sort of hard-nosed investigative reporting that we expect from the press today was not customary a century ago; the content of the *Orogrande Times* betrays its primary role as a mouthpiece and promoter for local business interests. Although the news reports about the smelter remained upbeat and optimistic, there was the occasional word of caution or plea for patience. For example, in the July 5, 1906 issue of the *Orogrande Times*, the lead story concerned the SWS&R Co.'s "vast projects," and acknowledged the frustrating delays in completing both the smelter and the water pipeline from the Sacramento Valley.

> The building of the smelter and the pipeline, the development of the mines, was a gigantic project—an undertaking of enormous magnitude. There have been delays; there always are in enterprises of this size and character. There have been delays beyond the thought of the average citizen. Nearly all the machinery that enters into the building of the smelter, and the thousands of tons of supplies, had to be transported vast distances, over railroads already congested with freight, and the machinery and supplies had to come from houses, already from two to three years behind in their orders. This will give an idea of the difficulties that have been encountered, the obstacles that the company has fought against and surmounted (*Orogrande Times*, July 5, 1906).

Once completed, the smelter operated for only six months before it was shut down in May 1908 (Charles 1966:16). Yet, even just two months before the shutdown, production reports were rosy.

> The smelter continues to turn out a high grade of matte. The ore output of the camp is steadily increasing and with this increased production the smelter will soon be able to reach its full capacity (*Western Mining World*, March 14, 1908).

Reportedly, 200 men were thrown out of work when the smelter ceased operations (*Western Mining World*, June 20, 1908). There appear to have been multiple reasons for the smelter's closure after such a short period of operation. One report suggests that the sulphides needed for

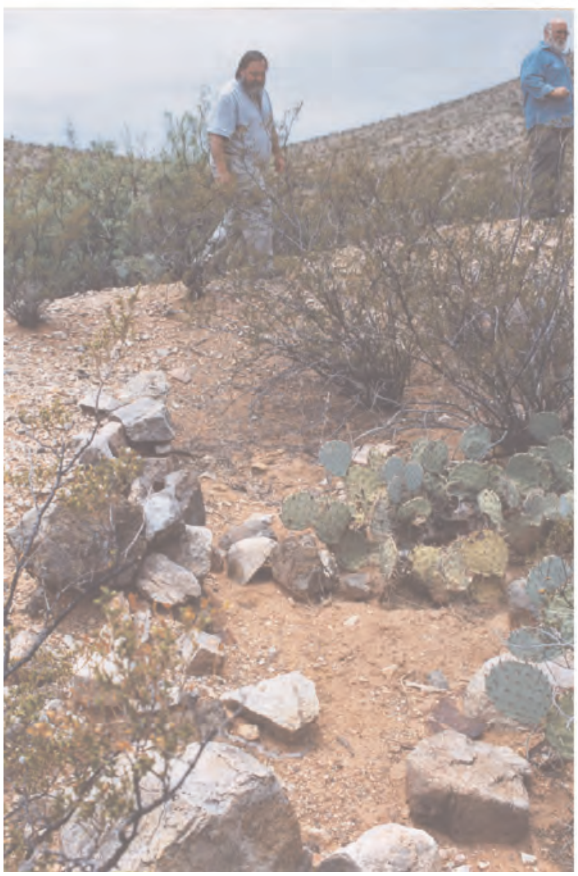

**Figure 32.14 Remains of dugout dwellings at Brice. Top: fragment of metal roofing in a shallow depression. Bottom, left: remains of a rock lined dugout dwelling, which probably had a canvas tent superstructure. Bottom, right: sherd of decorated ceramics in an area of dugout dwelling remains (Jim A. Railey/TRC 2001).**

**Figure 32.15** **Architectural remains in the Nannie Baird Mine area. Top: main mine building, now roofless (note the powder and food cans in the foreground). Bottom: the powder building (Jim A. Railey/TRC 2001).**



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**Table 32.3 Front-page News Stories in the *Orogrande Times* Concerning SWS&R Co.'s Smelter**

| Date | Headline/Title |
|---|---|
| 2/8/1906 | Work on the Big Smelter: Site is Being Graded, and it is to be Hurried to Completion |
| 2/15/1906 | Rushing the Work at the Smelter: Material Beginning to Arrive Rapidly; Things Will Hum from Now On. |
| 3/22/1906 | Work at Smelter Progresses Rapidly: Skeleton of the Building will be Reared in a Few Days, and Quickly Finished. Foundations Rest on a Bed of Caliche, and will Last for all Time—Material Arriving. |
| 4/5/1906 | Raising Smelter Iron: Skeleton of the structure is being erected at the present moment. |
| 4/12/1906 | Smelter Building is Being Rushed to Completion: Sampler assuming shape, and within thirty days the entire structure will be under cover. Will be completed in contract time and the plant blown in shortly afterwards. |
| 4/19/1906 | Smelter Work Rushed: It is being Hurried to Completion very Fast. |
| 5/3/1906 | Smelter Nearing Completion with Increased Rapidity: Sampler Will Soon be Enclosed and Work of Building Plant Finished Shortly. |
| 5/10/1906 | Big Pay Roll at the Smelter Office To-day: More Money To Be Distributed in Salaries Than Ever Before in Camp. |
| 6/21/1906 | Hurrying the Work on the Big Smelter: Very Little Work Remains to be Done on the Largest Reduction Plant in New Mexico. |
| 7/12/1906 | Rapid Progress at the Smelting Plant |
| 8/2/1906 | Smelter Will Be Completed in a Few Weeks |
| 8/16/1906 | Progress of Work at the Smelter: The Big Reduction Plant is Rapidly Nearing Completion and Will Soon "Blow In." |
| 9/27/1906 | Progress at Smelter: Reduction Plant Awaits Arrival of Only a Few Things to Complete it. |
| 11/15/1906 | Putting Finishing Touches on the Smelting Plant |
| 11/22/1906 | Preparations to Blow In The Smelting Plant: Laying Tracks in Smelter Yards to Commence in a Few Days, and Ore Will Pile into Bins above Sampling Works. |
| 12/13/1906 | Almost Ready to Blow in the Smelter: Work is being Rushed, and it is a Matter of Days Only when it Will be Ready to Commence Operations. |
| 12/20/1906 | Lincoln Consolidated is Shipping Ore to the Smelter |
| 1/3/1907 | Time of Blowing in the Smelter Nearing Rapidly: Finishing Touches on the Big Reduction Plant Being Pushed with Vigor |
| 2/23/1907 | Lincoln Company Shipping Ore Steadily to Smelter |
| 6/6/1907 | Smelter Is Ready To Blow In On The First Of July |
| 8/22/1907 | Will Smelter Blow In Next Month? Management Refuses to Make Statement But All Indications Serve to Confirm Current Rumor |
| 9/5/1907 | Much Activity at Mines and Smelter |
| 11/7/1907 | THE BIG SMELTER IS NOW IN OPERATION |
| 11/14/1907 | Furnace Running Little Above Intended Capacity: First Week of Operation, all That Could be Desired. |

smelting were not sufficiently plentiful in the mining district's ores (*Engineering & Mining Journal*, January 22, 1910). A sharp fall in copper prices in 1908 (*Western Mining World*, June 20, 1908) no doubt exacerbated the problems. Whatever the reasons, the smelter went into receivership and the SWS&R Co. reorganized as the Orogrande Smelting Company, remaining in operation until 1910 (North 1982:3). There were attempts to refurbish and reopen the smelter (*Western Mining World*, October 10, 1908; December 19, 1908), but its furnaces never operated again. It was finally sold on January 6, 1909 (*Western Mining World*, December 19,1908), and was eventually dismantled. Following the closure of the Orogrande smelter, ores from the local mining district were shipped to smelters in El Paso and Pueblo, Colorado. Today, the smelter's remains serve as a reminder of a colossal business failure caused, in part, by undue optimism and the overextension during Orogrande's boom days (Figure 32.16).

The smelter closure and fall in copper prices was the first major blow to the Orogrande mining dis-



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**Figure 32.16 The Orogrande Smelter. Top: Early twentieth-century panoramic photograph of the smelter, apparently looking west. Bottom: today looking east, from US 54, at the concrete base of the main stack (indicated by arrow in the top photograph), with slag pile visible in background. (Top photo from cover of Townsend [1998]; bottom photo by Jim A. Railey/TRC 2001).**

trict. In the following decade, the area would experience a short, second "boom." The rising and falling fortunes of Orogrande and its mining district can be tracked by the output of mineral ores over the years. Table 32.4 presents data on production output for Otero County from the USGS annual mining reports. Unfortunately, these data are not broken down according to specific mining districts; ore output from Otero County during these years came from three districts: the Jarilla Mountains, the Tularosa Mining District to the north, and (beginning in 1908) the High Rolls District in the mountains just northeast of Alamogordo. Still, the Jarilla district was the largest (at times the only) producer of mining products in the county for most of these years. North (1982:Table 2) provides figures on mining production for the Orogrande district alone from 1904–1981.

Several conclusions may be drawn from the USGS reports. One is the consistently miniscule percentage of ore production that Orogrande's district contributed to New Mexico's total output. Despite local claims that "(n)owhere in the Southwest are there greater deposits of mineral than in the Jarilla Mountains" (*Orogrande Times*, January 18, 1906, p. 2), it is clear from these figures that Otero County was not even the most productive in New Mexico, much less the American Southwest. Throughout the early twentieth century, Grant County and its Silver City Mining District led the way in ore production in New Mexico, far surpassing all other counties. Socorro County consistently held second place in mining output over this

period. Over the course of these years, Otero County never ranked higher than third (1908, 1917), and was in last place in 1909. Only in 1908 did Otero County contribute an appreciable percentage of New Mexico's ore output.

The figures in Table 32.4 also reveal year-to-year trends in mining output in the Orogrande Mining District, These data are augmented by verbal comments in the USGS yearly reports, presented in Table 32.5. The sudden drop in production in 1909 was due primarily to depressed copper prices, as well as the sudden closure of the smelter. Population dropped within the mining district at this time, and the Brice post office closed for a period beginning in 1909.

Orogrande's "second boom" of the1910s was stimulated initially by a rebound in copper prices, and later by World War I and the consequent increased demand for metal. Much of the focus shifted to iron production at this time, and the Ohaysi-Lucky Flats area became especially busy (Figures 32.17–19). The spur railroad was extended past Lucky Mine, through the cut in the mountain, to Ohaysi (Figures 32.20). People moved back into the area to work the mines; in 1919 Brice had a reported population of 300 (Sherman and Sherman

**Table 32.4 Registered Metal Ore Production* for Otero County, 1906–1923 (Source: USGS Annual Mining Reports)**

| Year | Gold (fine oz.) | Silver (fine oz.) | Copper (lbs.) | Lead (lbs.) | Ore (short tons) | % NM Ore Output (rank) | No. Prod. Mines |
|---|---|---|---|---|---|---|---|
| **1906** | 20.46 ($423) | 533 ($357) | 133,166 ($25,701) | 0 | 268 | 0.1% (7) | 3 |
| **1907** | 716.48 ($14,811) | 2,135 ($1,409) | 679,480 ($135,896) | 0 | 12,203 | 5.5% (4) | 10 |
| **1908** | 1,726.5 ($35,690) | 4,351 ($2,309) | 723,907 ($95,556) | 0 | 22,418 | 16.6% (3) | 9 |
| **1909** | 12.43 ($257) | 29 ($15) | 6,354 ($826) | 0 | 143 | 0.1% (8) | 3 |
| **1910** | 415.1 ($8,581) | 2,046 ($1,105) | 49,874 ($6,334) | 6,046 ($266) | 2,545 | 1.3% (6) | 6 |
| **1911** | 324.98 ($6,719) | 715 ($379) | 22,730 ($2,841) | 739 ($33) | 1,096 | 0.5% (6) | 6 |
| **1914** | 1,863.16 ($38,515) | 5,761 ($3,186) | 418,316 ($55,636) | 2,027 ($79) | 11,176 | 0.5% (5) | 13 |
| **1915** | 2,659.61 ($54,979) | 6,255 ($3,171) | 872,748 ($152,731) | 0 | 16,628 | 0.6% (5) | 15 |
| **1916** | 1,926.79 ($39,830) | 7,928 ($5,216) | 1,166,972 ($287,075) | 17,392 ($1,200) | 21,838 | 0.6% (4) | 26 |
| **1917** | 1,172.95 ($24,247) | 4,850 ($3,996) | 814,736 ($222,423) | 13,907 ($1,196) | 17,991 | 0.4% (3) | 19 |
| **1918** | 246.52 ($5,096) | 2,142 ($2,142) | 264,417 ($65,311) | 0 | 6,270 | 0.1% (5) | 9 |
| **1919** | 3.58 ($74) | 25 ($28) | 4,382 ($815) | 0 | 205 | 0.0% (8) | 2 |
| **1920** | 0 | 0 | 0 | 0 | 0 | 0.00% | — |
| **1922** | 0 | 0 | 0 | 0 | 0 | 0.00% | — |
| **1923** | 17.7 ($366) | 345 ($283) | 5,435 ($799) | 195,943 ($13,716) | 606 | 0.0% (8) | 4 |

* Note: For 1905, the USGS reported combined figures for Otero, Colfax, Rio Arriba, and Taos Counties. Figures were not available for 1912–1913, and 1921.



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**Table 32.5 Comments on Otero County from the USGS Annual Mining Reports**

| Year | Comments |
|---|---|
| 1905 | The year witnessed considerable activity in the [Jarilla] district, mainly in the way of development. Dry placers were operated at Jarilla by the Electric Mining and Milling Company and by several other parties. The [SWS&R Co.] began work on the Nannie Baird, Lucky, and other properties, and intends building a local smelter. The Three Bears Mining Company continued its operations and shipped some copper ore carrying a little gold and silver. |
| 1906 | The gain in value of the metallic product of Otero County was due mainly to increased activity in the Tularosa district. … The Silver Hill District, in the vicinity of Brice, was the center of much development work. The [SWS&R Co.] was building a concentrator and smelter, connecting the new plants with near-by properties by mine-gauge trams. The Electric Mining and Milling Company, while doing experimental work, produced a small amount of placer gold by dry process. The Calaveras Mining Association, at Brice, and the Lincoln Consolidated Copper Company, at Oro Grande, each made small shipments in 1906. Several other mines in this district were active last year. |
| 1907 | *Silver Hills district*—The largest increases in production centered around the operations of the [SWS&R Co.]. This concern completed its smelting works at Oro Grande and started the 250-ton matting furnace during the first week of November. This furnished a near market for the many small mines and prospects in the Jarilla Range, as well as for the company's own holdings, including the Lucky, By Chance, Nannie Baird, Iron Mask, Iron Queen, and other mines which the company has been developing for two years past. Shipments were also made from the Delusion, Monarch, Providence, Lincoln, and Garnet mines. This district furnished 8 out of 10 producing deep mines in Otero County during 1907. The Electric Mining and Milling Company transferred its holdings to the Texas-Jarilla Placer Mining Company, which company spent the year in erecting a milling plant, which went into commission on February 1, 1908. |
| 1908 | *Silver Hills district*—The smelter and mines of the [SWS&R Co.], at Oro Grande, were operated in 1908 continuously from January until May. The smelter is a 250-ton copper matting plant. The company's mines, the Lucky, By Chance, Nannie Baird, and others, have in mine openings and workings 5 vertical shafts from 90 to 480 feet deep, 3 incline shafts from 200 to 800 feet deep, and 2 tunnels 600 and 1,450 feet long. The Garnet group was worked under lease. The incline shaft on this property is 470 feet deep. Shipments were made from the Delusion, Monarch, Providence, and Copper Hill mines. The First National Mining Company, J.P. Nocker, and the Texas-Jarilla Placer Mining Company worked placer mines by sluicing. |
| 1909 | *Silver Hills district*—The smelter and mines of the Oro Grande Smelting Company were not operated in 1909. Shippers from this district were the Delusion, the Cuprite, and the Golden Gem and Alice group. The First National Mining Company operated the Golden Gate and the Duplex placers. |
| 1910 | *Silver Hills* (*or Jarilla*) *district*—This district lies near Brice post office, which is 2½ miles northwest of Oro Grande. The principal operating company in 1910 was the By-Chance Copper Co., which shipped copper ore to El Paso in December from the By-Chance mine. Two other small lots were shipped from this district. The Oro Grande smelter was idle in 1910. |
| 1911 | *Silver Hills* (*or Jarilla*) *district* (*near Brice*)—Oxidized ore carrying gold with iron in excess of silica was shipped from the Lucky mine of the Silver Hills district. Oxidized ore of the same character but carrying small quantities of silver, copper, and lead in addition to the gold, was shipped from the Maggie and Nannie Baird mines. The Oro Grande smelter was idle in 1911. |
| 1914 | *Jarilla* (*Orogrande, Silver Hill, Brice*) *district*—… There was no yield of placer gold in 1914. Producing mines were the By Chance, Delusion, Garnet, and Nannie Baird. All the ore was shipped to smelters. |
| 1915 | *Jarilla* (*Orogrande, Silver Hill, Brice*) *district*—… There was no yield of placer gold. Producing mines were the Alabama, By Chance, Delusion, Garnet, Mispah, Molly Gibson, Monte Carlo, and Nannie Baird. All the ore was shipped to smelters. In addition, considerable magnetite iron ore was shipped to the Colorado Fuel & Iron Co.'s steel mill, at Pueblo, Colo. |
| 1916 | *Jarilla* (*Orogrande, Silver Hill, Brice*) *district*—Lode mines in this district in 1916 produced 20,195 tons of ore … This is the largest production at least since 1904, when the Geological Survey records begin. There was also a small yield from the Little Joe-Cashins group placer property, the gravel of which is treated in a small amalgamation-concentration mill. Producing deep mines were the By Chance, Delusion, Fannie, Garnet, Gem, Lincoln, Lucky, Mexican, Mispah, Nannie Baird, and Turquoise. All the ore was shipped to smelters. In addition, considerable magnetite iron ore was shipped to the Colorado Fuel & Iron Co.'s steel mill, at Pueblo, Colo. |



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**Table 32.5 Comments on Otero County from the USGS Annual Mining Reports (continued)**

| Year | Comments |
|---|---|
| 1915 | *Jarilla* (*Orogrande, Silver Hill, Brice*) *district*—There was no yield of placer gold. Producing mines were the Alabama, By Chance, Delusion, Garnet, Mispah, Molly Gibson, Monte Carlo, and Nannie Baird. All the ore was shipped to smelters. In addition, considerable magnetite iron ore was shipped to the Colorado Fuel & Iron Co.'s steel mill, at Pueblo, Colo. |
| 1916 | *Jarilla* (*Orogrande, Silver Hill, Brice*) *district*—Lode mines in this district in 1916 produced 20,195 tons of ore … This is the largest production at least since 1904, when the Geological Survey records begin. There was also a small yield from the Little Joe-Cashins group placer property, the gravel of which is treated in a small amalgamation-concentration mill. Producing deep mines were the By Chance, Delusion, Fannie, Garnet, Gem, Lincoln, Lucky, Mexican, Mispah, Nannie Baird, and Turquoise. All the ore was shipped to smelters. In addition, considerable magnetite iron ore was shipped to the Colorado Fuel & Iron Co.'s steel mill, at Pueblo, Colo. |
| 1917 | *Jarilla* (*Orogrande, Silver Hill*) *district*—Lode mines in the this district in 1916 produced 15,558 tons of ore … This production, in point of gross value, is the largest on record for the district, except that for the year 1916. There was also some production of placer gold from the Little Joe placer, the gravel of which was worked by jigs, trammels, and shaking riffles. Producing deep mines were the By Chance, Delusion, Garnet, Gem, Iron Mask, Mexican, Nannie Baird, Providence, Turquoise, and Verde. In addition, considerable magnetite iron ore was shipped to the Colorado Fuel & Iron Co.'s steel mill, at Pueblo, Colo. |
| 1918 | *Jarilla* (*Orogrande, Silver Hill*) *district*—Producing mines were the Delusion, Garnet, Iron Mask, Lucky group, Molly, and Providence. Some of the mines were idle after July. There was no placer production in 1918. Iron ore was shipped to the steel plant at Pueblo, Colo. |
| 1919 | No work was done in the Highrolls (Sacramento) and Tularosa districts in 1919. |
| | *Jarilla* (*Orogrande, Silver Hill*) *district*—[This] district shipped much iron ore to the steel plant at Pueblo, Colo., up to November 1, when the labor strike at Pueblo stopped all shipments. Ordinarily this district also sends considerable quantities of gold and silver bearing iron and copper ores to the smelter in El Paso, but in 1919 it shipped only 205 tons of these ores. |
| 1920 | No ores containing gold, silver, copper, and lead were shipped from any of the districts in Otero County, but iron ores were shipped to the steel plant at Pueblo, Colo., from Orogrande. At the Little Annie mine, at Orogrande, a small milling plant, consisting of a crusher, a Huntington mill, and amalgamating plates, was operated, but the bullion produced was not refined or sold. |
| 1922 | No ores were shipped from the Orogrande district, which was until 1922 a contributor of iron ores to the steel plant at Pueblo, Colo., and until 1921 of iron-copper-gold ores to the El Paso smelter. |
| 1923 | *Orogrande district*—Several cars of lead-silver and lead-silver-gold ores were shipped from [this] district … |

1975:21). Ohaysi opened a post office in 1916 (Townsend and McDonald 1998:89), and Brice's post office reopened in 1919 (Sherman and Sherman 1975:21). A traveling circus even came to Lucky Flat in 1913 (Webb 1982:43). In 1916 Orogrande reportedly had

> A 32-bed hospital, a 63-bedroom hotel, a weekly newspaper (The Jarilla Enterprise), nine saloons, two feed and grain stores, two lumber yards, four grocery stores, and a drug store (Lovell 1963:20).

This second boom, however, fizzled quickly after 1919. In 1922 no ores were shipped from the mining district (see Tables 32.4 and 32.5).

Abandonment of the mining district was well underway in the early 1920s. The Brice post office, which had reopened in 1919, closed for good the following year (Sherman and Sherman 1975:21), and Ohaysi's post office closed in 1921 (Townsend and McDonald 1998:89). Webb (1982:68) reports that only two students graduated from the Brice school in 1923 (it should be noted, however, that many children in the area never graduated). Many buildings fell into disrepair or were demolished; the lumber and other hardware were scavenged for construction elsewhere.

There was a slight resurgence in ore production in the district during the late 1920s, mostly copper



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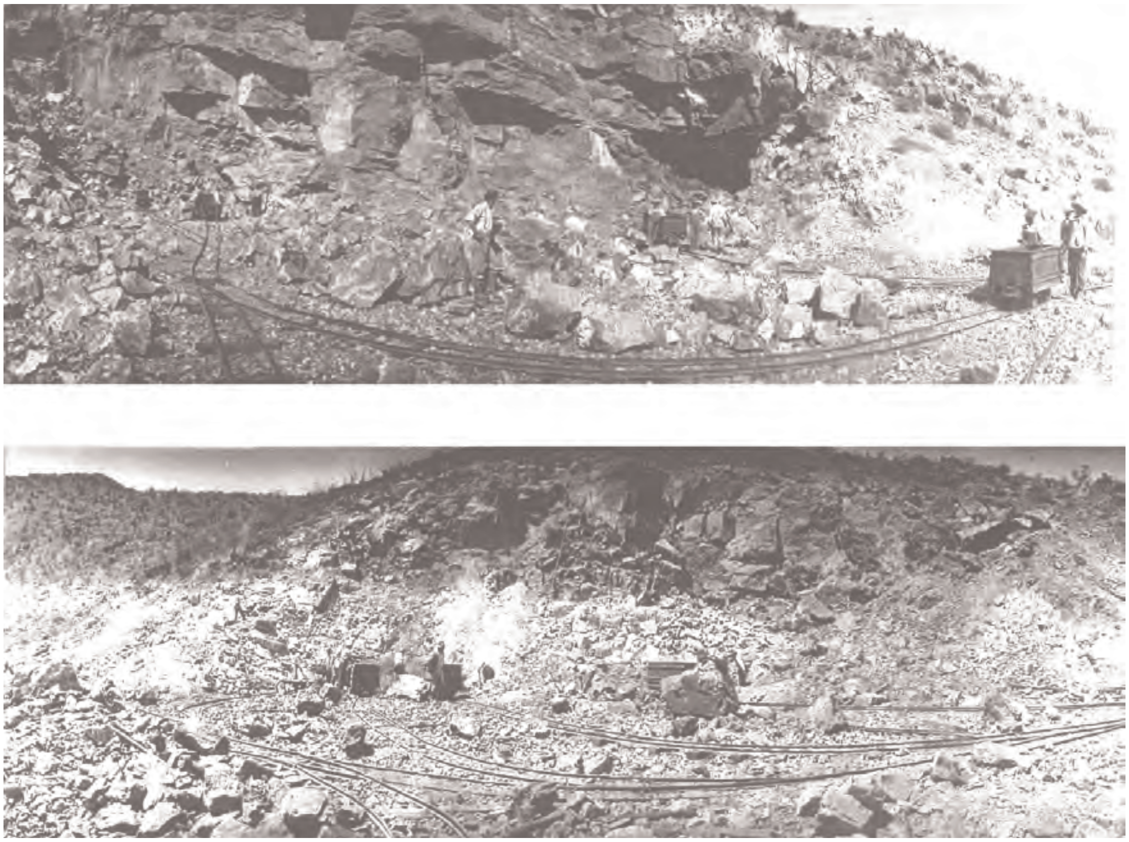

**Figure 32.17 The Iron Duke cut was located high in the Jarillas, at the far northwest end of the mining district. Work here was especially intense in the 1910s, after the spur line was extended to the Ohaysi area.**

output. During the depression years of the 1930s, an attempt was made to reinvigorate the Orogrande mining district. Stock certificates were issued, and there was a small amount of gold recovered from small-scale placer operations (North 1982). But this effort quickly dissipated. The Civilian Conservation Core (CCC) did some work in the area during the 1930s; the CCC bunkhouses are still visible in a 1941 aerial photo of Orogrande (Figure 32.21). Clif McDonald (personal communication 2001) reports that he helped his father shear sheep at the Little Joe mine in 1938, and he swam in the Brice reservoir at that time. According to William Ward (personal communication 2001), around this time a German man carried out underground placer mining just northwest of Orogrande, living as a hermit in a two-room, subterranean dwelling accessed by a shaft opening (Figure 32.22). According to Ward's account, this man reportedly went into town once a week for 10 gallons of water, which he used for personal consumption, hygiene, and for his mine washers. One day in 1941, it was noticed that he had not come into town according to his usual schedule. Some residents went down into his mine shaft home and discovered he had passed away.

With the United States' entry into World War II, demand for metal rose in response to military production needs, and raw materials were once again extracted from the Orogrande district. This time, however, metal was obtained not from the mines, but from the abundant scraps left over from the mining activities of previous decades. Railroad tracks, discarded machinery and parts,



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Figure 32.18 Jarilla district mining in the 1910s. Top: 1917 photograph of the Cinco de Mayo mine, located at the far northwest end of the Orogrande mining district. Bottom, left: 1914 photograph showing a group of Mexican miners. Bottom, right: group of white mine workers (courtesy of Rio Grande Historical Collections, New Mexico State University).



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Figure 32.19 The Ohaysi/Lucky Flats area today. Top: overview of the Ohaysi/Lucky Flats area (flat area in central portion of photo). Bottom: a habitation locality at Lucky Flats; note the cans and other debris in the foreground (Jim A. Railey/TRC 2001).

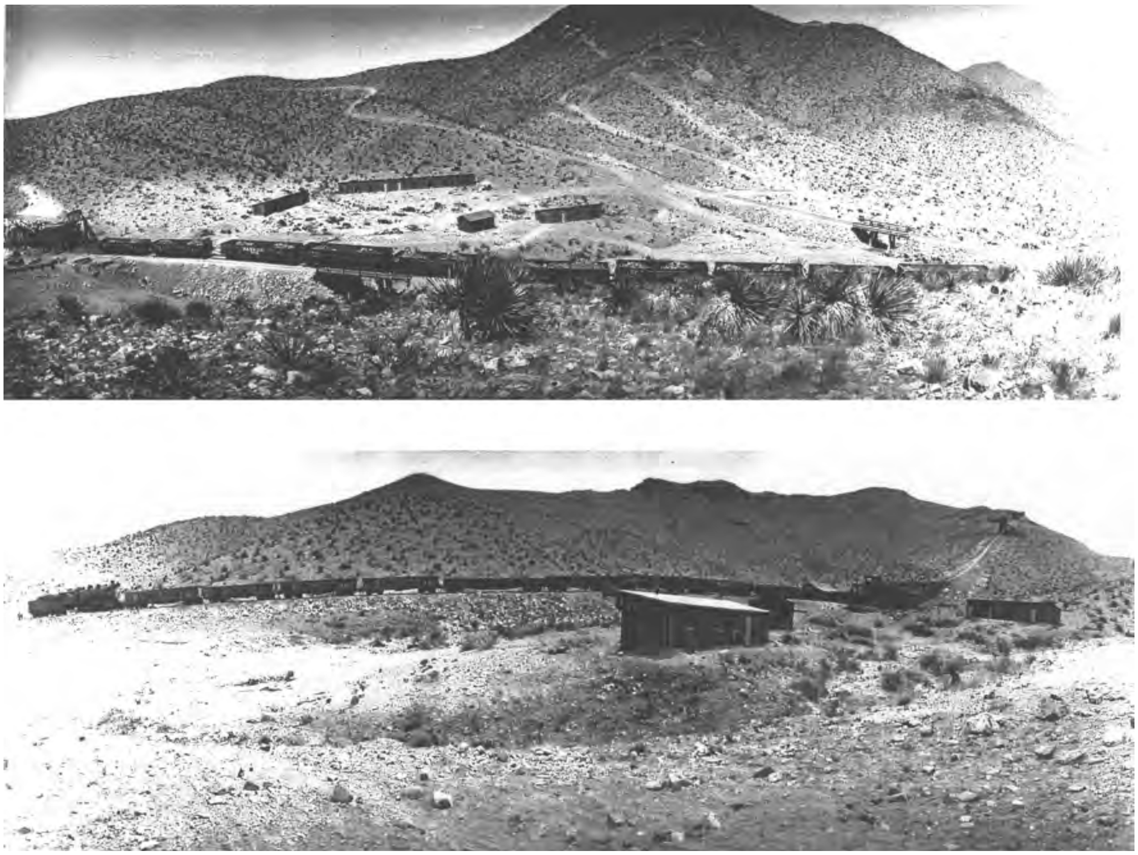

**Figure 32.20 Two views showing the terminus of the extended spur railroad line in the late 1910s. The frame trestle-like structure is the tramway terminal, which received loads of ore from the tramway that ran down the mountain from the Cinco de Mayo and Iron Duke mines (courtesy of Rio Grande Historical Collections, New Mexico State University).**

and all other available metal debris was salvaged and hauled away for the war effort. The spur line that is part of LA 115258 was dismantled at this time (Robert Ward, personal communication 2001).

From the late 1940s to the present, mining activities in the Orogrande district have been small scale and sporadic. There were small production "blips" in the mid 1950s, the late 1960s, and the late 1970s. In the 1960s, there was hope that Orogrande might be revived. The El Paso Real Estate Company sold lots in the town during the early 1960s, in the hope that military personnel from the nearby White Sands Missile Range might make their homes there, and new industries might develop. These hopes, however, never came to fruition. In 1967, an open pit copper mine operated near Orogrande, raising hopes that the district might make a comeback as a metals production center (*El Paso Herald*, May 11, 1967), but this hope was also short-lived. Today, most mining in the district is for recreational purposes, and is carried out in the placer deposits just outside the town of Orogrande. By the 1970s, Orogrande's population had been reduced to less than 100 people, and remains at this level today. The mining towns in the mountains have long been abandoned; they have become a recreational attraction for occasional visitors. The Bureau of Land Management (BLM) now owns much of the mining district, although parts of the district remain on private holdings and some patented claims are still current. Bill Ward settled in


**Figure 32.21** 1941 aerial photo of Orogrande (Tobin Aerial Survey). The arrow indicates the CCC camp.



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Figure 32.22 Subterranean shaft dwelling of German miner who lived as a hermit and died here in 1941. Shaft is sunk into placer deposits on the bajada apron along the southeast ern flanks of the Jarilla Mountains. Bill Ward visible in lower photograph (Jim A. Railey/TRC 2001).

Orogrande in the 1970s, and raised his family there. He continues to carry out small-scale placer mining, and has obtained a great deal of knowledge about the area's history, which he shares during his jeep tours of the mining district.

In the early 1990s, archaeological excavations at Pendejo Cave, along the escarpment of Otero Mesa, brought a team of archaeologists to Orogrande for several seasons. Directing the excavations was the noted archaeologist Richard S. ("Scotty") MacNeish, who uncovered possible evidence of pre-Clovis occupation at the cave, making it one of the most potentially important sites in American archaeology. In 1997, Human Systems Research, Inc. (HSR) conducted archaeological documentation of abandoned mines and other facilities in the Brice/Nannie Baird area (Comer 1998). The work was part of a hazard abatement and reclamation project sponsored by the New Mexico Energy, Minerals, and Natural Resources Department. The department plans to seal the more hazardous mines to prevent injuries to recreational visitors.

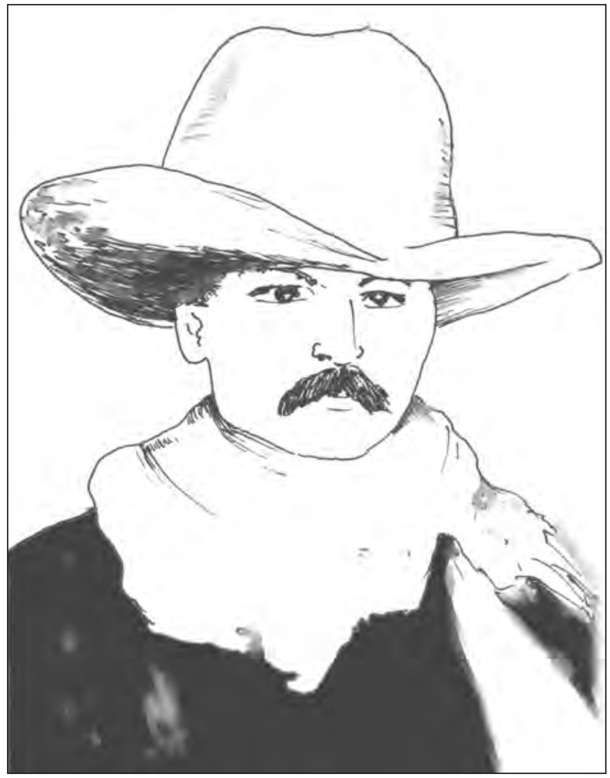

**Figure 32.23 Drawing of Robert Lois ("Bob") Raley, from photograph in Webb (1982:xiii). Drawing by Jim A. Railey.**

## The Raley Story: Orogrande As Seen Through A Family History

Most historical accounts of Orogrande and its mining district, while providing tidbits of interesting historical events, nevertheless leave us with only a backdrop to the personal lives and dramas that unfolded here over the years. Individual memories of most past residents are now lost to the desert sands, but thanks to a family history compiled by Maurine Webb (1982), we have a most vivid account of daily life in the Orogrande mining district. Webb is a descendant of Robert Lois ("Bob") Raley (Figure 32.23), who was among the more colorful figures in Orogrande's history. Through family oral histories and archival record searches, Webb reconstructed the story of Bob, his wife Lucy, and their children. The details of the Raley's life illustrate the character of the times. The story is especially important because it deals with an individual who arrived in the area not as a wealthy robber baron or promoter, but rather as one among many of the gritty, rank-and-file laborers looking for a place to settle, raise a family, and pursue his hopes and dreams. Thanks to Webb's transcript, Raley's story breathes life into Orogrande's history in a unique and personal way.

Bob Raley was born in Texas sometime around 1870. His father, Samuel G.B. "Green" Raley was a Confederate Civil War veteran from Alabama. Bob's mother died around 1880 and Green placed Bob in an orphanage, then left for Latin America to work as a laborer on various jobs, probably including mining, railroad construction, and cow punching (he may also have worked on construction of the Panama Canal). Around the age of 14, Bob traveled to Mexico where he joined his father and worked at different jobs. Bob's adventures at this involved time included run-ins with Mexican revolutionaries, and with a group of Texans with mining interests

in Mexico; both experiences left Bob wounded physically. Bob and his father returned to Texas in 1898, and "Green" died shortly afterward.

Bob then moved to New Mexico, settling first in the Carlsbad area where he reportedly worked breaking horses. By 1900, the young cowboy was working for Bill McNew. Bob's work for McNew took him into the Sacramento Mountains in 1901, where they gathered cattle and delivered them for shipment at Turquoise, on the rail line seven miles north of Jarilla Junction (Orogrande). Bob and the other cowboys would ride into Jarilla Junction to play cards in one of the saloons. Disputes over these card games worsened the brewing tensions between Raley and McNew.

On November 10, 1901, Bob was married to Lucy Gilliland, sister of one of Bob's and McNew's fellow cowboys. They were reportedly married in Jarilla (Brice), the ceremony presided over by the Justice of the Peace, G.E. Moffett (who also owned the Little Joe placer mine). At this time, Bob Raley was working as a construction and maintenance laborer on the rail line from Newman (at the Texas line) to Carrizozo. He and Lucy lived in one of the trains' boxcars "moving along as the rails were laid" (Webb 1982:14). After his short stint with the railroad, Bob and Lucy moved into a frame house at Jarilla (Brice). Their first child, Mary Lucy, was born on August 25, 1902 in Cloudcroft, where they probably settled temporarily to escape the oppressive heat of the valley while Lucy gave birth.

After Mary Lucy was born, the Raleys returned to Brice and by 1904 had settled on an unclaimed piece of flat land approximately six miles southwest of the Jarilla Mountains, "where the grass was belly high to a horse" (Webb 1982:14). Here at the "Well Place," they built a frame house and dug a 362-foot-deep well. The water this well yielded was salty. Still, they must have been able to use the water for watering cattle and perhaps irrigation, because they installed a windmill there. That same year, their second daughter was born in the two-room hospital at Alamogordo (she was a premature baby). Their third daughter, Ruth Robert, was born at the Well Place in 1905. During these years, Bob was away much of the time working on various jobs, including laboring in the mines. It was Raley who in 1905 recovered the gold nugget that gave Orogrande its name (see Figure 32.6, above). Bob also developed another homestead at this time, called the "Tank Place," located on a mining claim in the southwestern flanks of the Jarilla Mountains (Figure 32.24). This homestead was linked to a series of water catchment facilities, including reservoirs, spillways, and retaining walls that Bob constructed here. The Raley's fourth child, Rachel Rose, was born at the Tank Place in 1907. At this time his brother, Samuel David Raley, and his family came for a visit. They stayed with Bob's family at the Tank Place, their sons attending the public school at Brice. Samuel reportedly had trouble making a living as a mine laborer, and soon left for Arkansas.

In 1908, Bob and his family divided their time between the Tank Place and the Well Place, and their first son, Richard Lafayette, was born at the Well Place that year. Bob continued to make a living through various means, including breaking horses, running cattle, and leasing his grasslands for grazing. In 1908 or 1909, Raley filed a mine claim at a location on the northwest flanks of the Jarillas known as the North Well, probably to secure another water source. For supplies the family made frequent trips into Orogrande, and to Alamogordo where Lucy had family. Orogrande and Brice at this time were small, yet bustling communities.

> Orogrande in those days was a typical mining town with sand surface roads on streets, seven saloons, two large department stores, an unknown number of red light houses, no churches, two hotels, and many boarding houses. There was Keans grocery store and Mrs. Harry Vorhese was the postmistress. The Calthrop house had

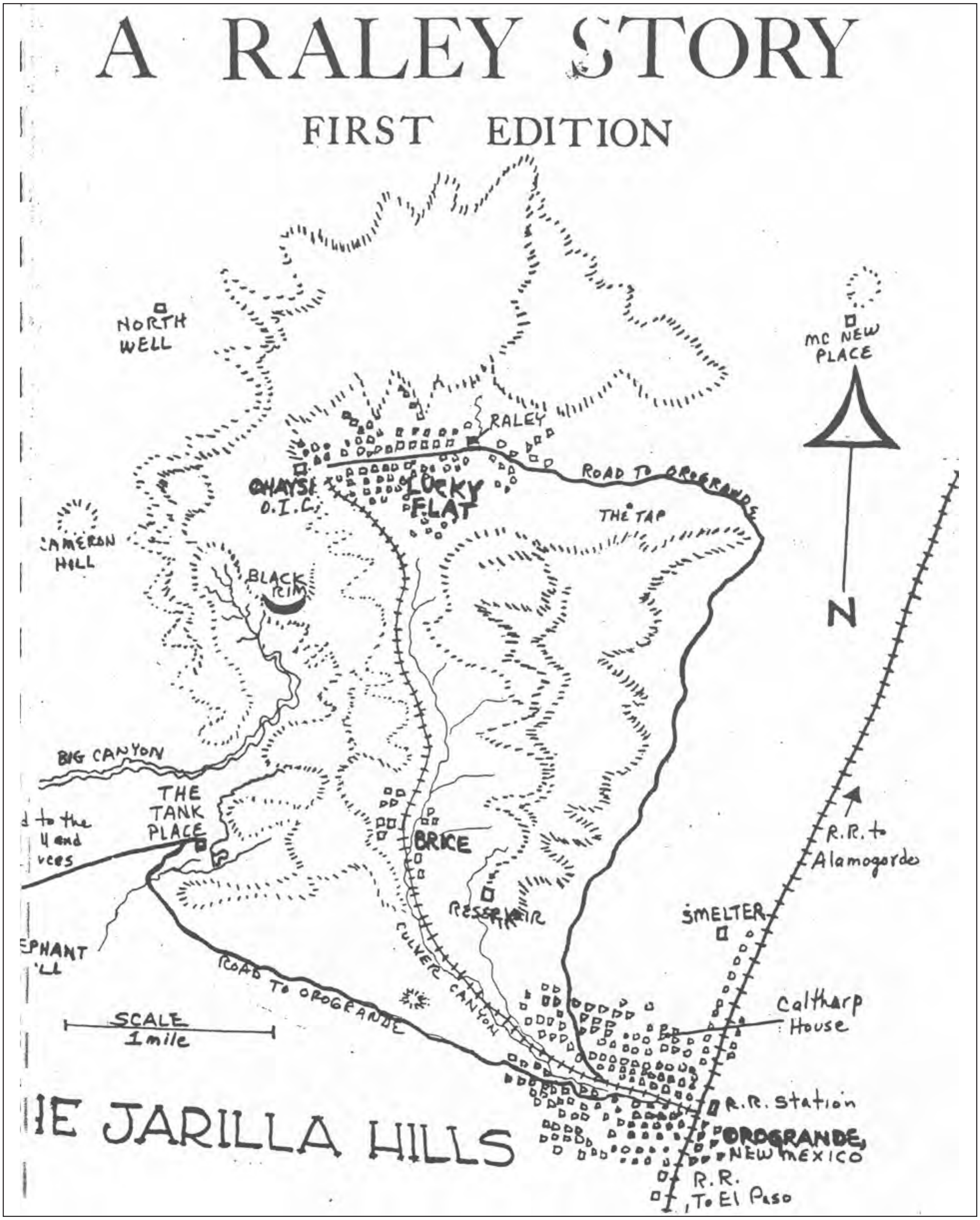


Figure 32.24 Hand-drawn map on the cover of Webb (1982), showing the mining district and landmarks associated with the Raley family.



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> the only telephone in town. In Brice, the post office was a cubby hole in the north end of Culver's saloon. Three train loads of ore was hauled out of the hills each day at the height of the boom (Webb 1982:26).

In 1909, the Raley's moved to Lucky Flat, although they still continued to live and work at their other homesteads. One day in 1910, while drinking whisky in an Orogrande saloon, Bob shot Bill McNew in the ear lobe. Raley was arrested and brought to trial in Alamogordo. According to Webb (1982:31), the jury consisted of both whites and Mexicans, and there were difficulties translating the proceedings of the trial. Raley, who was bilingual (he learned Spanish while living in Mexico), reportedly was charged with contempt of court 12 times during the trial over disputes involving translations. Raley was convicted and served several months in the Alamogordo jail. Lucy and the children stayed with her parents in Alamogordo while Bob served his time.

Bob was released in the summer of 1911 and returned to his various pursuits, although he was still somewhat weakened from a bout of food poisoning he had while in the Alamogordo jail. He built a four-room frame house at Lucky Flat, along with a shed where he butchered sheep to sell to the neighboring miners and other residents. They also reportedly got a cow and sold milk locally. In addition, Bob hauled ore for the mines (the spur rail line did not reach the Ohaysi/Lucky Flat area at this time). Over the next few years, the family divided their time between Lucky Flats and the Tank Place, while Bob worked various jobs in the area. In 1913, Lucy gave birth to their seventh child (all born within a 10-year period). In 1914, Bob had a job digging a well near old Fort Selden on the Rio Grande; the whole family went with him, where they lived in two tents.

In September 1915, charges were filed against Raley for hunting illegally in his federita field at Lucky Flats (the charge was disputed). The following day, September 23, Raley went into Orogrande to await a telephone call from his Alamogordo attorney at the Calthrop House. As he was opening the front yard gate, a rifle shot from inside the Calthrop House struck Raley in the head, killing him instantly. Lucy, who was by his side, was nearly hit by subsequent shots. They buried Bob the following day in the Orogrande cemetery, in a grave that is today unmarked. It is uncertain to this day who murdered Raley. Lucy remained convinced it was his old nemesis, Bill McNew, who was reportedly inside the house with several other men. Lucy brought charges against McNew, but the prosecution failed and McNew, who had allegedly gotten away with 18 other murders, went free (Webb 1982:46).

Following Bob's death, Lucy Raley and the children continued to live at the Tank Place homestead and their house at Lucky Flat. The oldest child, Mary (now age 13), hauled 50-gallon barrels of water to Lucky Flat and sold them for 50 cents a barrel. Lucky Flat was beyond the reach of the pipeline and all water was still being hauled to this part of the mining district, which was very active at this time. The family also got by on what remained from Bob's $2,000 life insurance policy, minus the $500 Lucy paid the lawyer to prosecute McNew (she was convinced McNew paid the lawyer more), and $500 loaned to Lucy's brother (which was reportedly never paid back). In addition, they sold products from their goats and other animals, with help from friendly neighbors. Before the year was out, Lucy and the children moved away from Lucky Flat for the last time. But they retained ownership of the frame house, renting out three of the rooms for $2 each, and leaving the other room for anyone who would come and tend their goats. In 1919 Lucy sold the Lucky Flat house, and it was demolished soon after.

Over the next two decades, Lucy continued to live at the Tank Place as the children, one-by-one, went away to be married and carry on their own

adult lives. During World War II, military training exercises were held in the flats below the Tank Place. The Tank Place had become military property; the Raleys lived there by virtue of a mining claim, and never owned the property outright. The army was apparently unaware of the homestead in the nearby hills, and sometimes fired shells in the direction of the Tank Place. Lucy finally left the homestead in 1944, moving to El Paso, where she lived until her death in 1956. In the meantime, army military training exercises heavily impacted the Tank Place and many of its features were dismantled or otherwise destroyed.

The Raley story reveals many details about everyday life over the years in the mining district (many more than are included here). If not for Webb's account, such details would have been completely lost to history. The story reveals much about the interpersonal dramas that shaped the history of the people living in the area, but also touches on some of the landmarks whose ruins are still visible there today. For example, the Brice Schoolhouse served not only as a place of learning, but also for social gatherings, including occasional church services presided over by an itinerate preacher. It is not clear to what extent these accounts are accurate; some information in Webb's transcript contradicts that in other sources. Consider her account of there being only one telephone in Orogrande, at the Calthrop House, in 1908 (Webb 1982:26). Lovell (1963:20), on the other hand, states that there were 216 telephones in use around this time, and that Mrs. Bess Voorhees operated the exchange. This agrees with an oral account provided by Bill Ward (personal communication 2001), who reports that Mrs. Voorhees, who succeeded her husband in this role, ran the telephone exchange and post wireless and sold 30-day mine claims (Ward also reports there were 519 telephones, as opposed to only 11 today). Mrs. Voorhees provided these services out of her general store, a building believed to have been constructed in 1905, that still stands today.

Despite these inconsistencies, the Raley story provides many vivid accounts concerning technology at the time, medical practices, diet, hygiene and sanitation, modes of travel, material privations experienced by the area's residents, social conditions (including relations and tensions between whites and Mexicans), and amusing stories of children's antics that today would constitute liability nightmares. There are also references to the climate and biotic environment that underscore the differences in the area between then and now. Consider Webb's entry under the year 1913.

> In those days, there was more rainfall and people could grow gardens. The winters were colder and there was a lot of snow and ice; the tank froze every winter" (Webb 1982:37).

Similarly, her entry for the year 1916 described the Tank Place, where "the gramma grass was tall on the hills and there was almost always water in the tank and the cistern there" (Webb 1982:49). Period photographs of the mining district, however, show an arid, desert regime similar to that prevailing today, although it is not clear to what extent mining and human activity at the time may have impacted the natural flora. Visiting the parched and abandoned desert environment today, it is difficult to imagine the grassy expanses, agricultural fields, and gardens that once thrived here, as well as the bustle of mining activities and community life that now survives only in archives, written and oral histories, and archaeological remains.



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Chapter 33

# SUMMARY AND RECOMMENDATIONS

Jim A. Railey

## Introduction

Archaeological testing and data recovery at 22 sites along US 54 have made many important contributions to the archaeology of the Jornada Mogollon region in general, and the southern Tularosa Valley in particular. Although previous work had been carried out in this area, the US 54 project results shed considerable new light on prehistory here, especially for the Late Formative period. Investigations at Jaca (LA 6829) and LA 115260/115265, in particular, produced unexpected results that broaden our understanding of the Doña Ana phase and early portion of the El Paso phase. In this chapter, the results of the investigations are summarized and assessed in terms of 1) site-by-site results, 2) the specific research issues outlined in Chapter 4, and 3) recommendations.

## Investigated Sites

### *Data Recovery Sites*

**The Jaca Site (LA 6829)**
This was by far the most productive of the 11 data recovery sites investigated along US 54 (see Chapter 6). It lies at the foot of the alluvial fans draping the southeastern flanks of the Jarilla Mountains. Although the site appears to have been occupied during multiple periods, within the investigated right-of-way the vast majority of the remains dated from the late Doña Ana phase and very early portion of the El Paso phase. Most of this component was spatially confined to the site core area, which occupies approximately 100 m along the right-of-way within the north-central portion of this very extensive site. Within the core area, the remains of 18 structures were uncovered, most of which were simple, informal pithouses. This is unusual for such a late site; pithouses have been previously documented for Late Formative times, but to find a late Doña Ana or El Paso-phase settlement made up primarily of low-investment pithouses is unprecedented. The Jaca site structures were spatially segregated into two clusters, one in the northern part of the core area, and the other in the southern portion.

The largest of the pithouses at Jaca, Structure 2, had a plastered floor, and so is considered a special structure, probably used for ceremonial purposes. This structure is much smaller than other large, communal or ceremonial pithouses known for the Doña Ana phase, or even the late Mesilla phase (see Chapter 31). Built directly on top of Structure 2 was a large, rectangular structure that appears to be a communal room, Structure 1. Like the underlying Structure 2, this structure also had a plastered floor, plus a variety of floor features. These include four main support posts in a rectangular array, and these posts may have originally supported the Structure 2, and if so were simply left in place and re-used for Structure 1. Smaller postholes were also documented on the floor of Structure 1, along with several non-thermal pits and two burials (one in a pit and one placed on the house floor). A collared adobe hearth was found in the south-central portion of the Structure 1 floor, and another plastered hearth, which lacked the raised collar, was located in the northeastern quadrant of the floor. Although the collared hearth was found in the customary location for late Doña Ana- and El Paso-phase rooms, no accompanying adobe step was found at the center of the south wall in Structure 1.

Structure 1 may have been part of a linear roomblock. The walls of what appears to be a slightly smaller, adjoining room (Structure 3) were observed in the profile along the right-of-



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way edge, immediately west of Structure 1. It remains unknown how many additional rooms (if any) might extend further to the west (outside of the right-of-way), but no other rooms were observed east of Structure 1. The only other type of structure uncovered at the site was a post construction that may be a surface dwelling or a pen of some sort.

Besides structures, the Jaca site also yielded large numbers of other features including 76 thermal pits (58 small and 18 large), 22 FCR/BC concentrations, 40 non-thermal pits (12 small, 13 medium, 14 large, and one of undetermined size that was only partially exposed), two caliche caps, and several postholes. Among the large, non-thermal pits were eight that were exceptionally large, typically irregular in shape, and contained smaller pits along their extensive floors. These features are tentatively interpreted as *huecos*, or water catchment and retention features. They are much smaller than the artificial, Late Formative reservoirs identified in the vicinity of the Hot Well site to the south. From the smaller size of the Jaca site *huecos*, it would appear that water catchment and management at this site was a household-level activity, whereas the Hot Well Reservoir represents a more communal effort. The Jaca site investigations thus provide new, potential evidence of local variation in the organization of labor surrounding the acquisition and management of the region's most critical resource—water.

The Jaca site contained the highest proportion of non-thermal to thermal pits among the US 54 sites, even excluding the possible *huecos*. This suggests that activities, such as subterranean storage, were more prevalent here than at any of the other US 54 sites (see Chapter 30), and this is in keeping with the relatively large-scale, intensive nature of the site occupation at Jaca.

The Jaca site investigations produced a large quantity of artifacts, including 16,634 ceramics, 4,334 lithics, and abundant biological remains. The lithics were comprised mostly of chipped stone debitage, and this assemblage indicated a typical, Late Formative technological focus on core-flake and expedient tool production. Silicified shale, a low-grade but locally available material, dominated the chipped stone assemblage. Only seven projectile points were recovered, and only four of these were recognizable Late Formative types, with the others including two Late Archaic forms and an untyped one. The ground stone assemblage was dominated by manos, metates, and untypable fragments. A variety of manos was recovered, including both one- and two-handed forms, with recognizable cross-sections dominated by wedge-shaped and parallel-face types. Both basin and slab metates, but no trough forms, were recovered.

Plant remains recovered at Jaca include macrobotanicals, pollen, and phytoliths. Preservation conditions at this site were comparatively good, and all three categories of plant remains included maize, and beans were present in both the macrobotanical and phytolith assemblages. Bottle gourd was also identified within the macrobotanical remains. The remains of domesticated plants from Jaca suggest that the site occupants were practicing intensive farming, probably on-site or in the small playa that lies immediate to the south of the site. Besides domesticates, a wide variety of other remains, including wild edible plants and wood charcoal, was also recovered. Lipid residues extracted from FCR found in thermal features indicated both plant and animal foods were processed in pit ovens at the site.

Along with LA 115260, Jaca was one of two sites to yield a substantial assemblage of faunal remains. Jackrabbit dominated the identifiable remains at Jaca, although a higher proportion of both cottontail and artiodactyls was present at Jaca than at LA 115260, the only other site that produced a substantial number of faunal remains.

The variety of ceramic types from the site indicates an occupation span ranging from the Doña Ana phase into the early El Paso phase. This is supported by a series of 22 radiocarbon dates

from the site, the two-sigma calibrations of which fall within, or least overlap, the time spans of the Doña Ana and El Paso phases. Considered together with stratigraphic data from the site, the ceramics and radiocarbon dates indicate the Late Formative occupation at Jaca spans perhaps no more than a century, between ca. A.D. 1200 and 1300. The evidence also suggests that the beginning date for the El Paso phase is perhaps best set at A.D. 1250 rather than 1200.

Despite the apparent brief time span of the occupation within the Jaca site core area, stratigraphic, radiocarbon, and ceramic data allowed us to tentatively propose a three-period sequence (Jaca I–III) for the site's structures (although due to data shortages for some pithouses, not all of them could be placed within this sequence). Jaca I, which is considered here to fall within the very late Doña Ana phase, includes eight pithouse structures, including the formal pithouse (Structure 2), along with the post structure (Structure 4) and most or all of the probable *huecos*. Jaca II, which is treated here as transitional between the late Doña Ana and early El Paso phases, includes the probable room block (Structures 1 and 3), along with two simple pithouses in the southern portion of the core area. Jaca III, which corresponds to the early El Paso phase, was the final period of the site's occupation. At this time, the room block apparently was abandoned. This period includes only four pithouses, two each in the northern and southern clusters within the core area. Partial filling of the Structure 1 basin apparently occurred during this period.

The Jaca site broadens considerably our image of the Late Formative period. This is the only well-documented site in the region that clearly spans the interval from the end of the Doña Ana phase to the beginning of the El Paso phase. The probable room block, represented by Structures 1 and 3, apparently marks one of the earliest attempts at pueblo construction in the Jornada Mogollon region. The presence of so many simple, informal pithouses at the site is surprising for this time frame. By themselves, these structures would seem to indicate that the site occupation was part of a highly mobile settlement system similar to what prevailed during the Late Archaic period and Mesilla phase. But contradicting this is the abundant evidence for agricultural production at the site, as well as the apparent room block, which indicate a greater degree of sedentism than the simple pithouses themselves would otherwise suggest. Moreover, lying at the foot of an alluvial fan adjacent to a small playa, Jaca is in a classic locational setting for Doña Ana- and El Paso-phase agricultural sites. The mixed signals embodied in the archaeological evidence from this site underscore the highly dynamic nature of settlement-subsistence patterns and sociopolitical organization at this time, and the apparent abandonment of Structure 1 by Jaca III times reflects the risky, often unsuccessful outcome of attempts to construct pueblos during the El Paso phase.

**LA 115256**

This was a small occupation site situated on the lower bajada slope just northeast of the Jarilla Mountains. Within the right-of-way, only two thermal features (Features 1 and 3) were encountered and excavated, and these were separated by more than 20 m. Within and surrounding Feature 1 (the southernmost of the two features) was a small concentration of undecorated brownware sherds, and additional brownware sherds were located approximately halfway between Features 1 and 3. Feature 3 did not yield any diagnostic materials, but a radiocarbon date of A.D. 330–560 (two sigma, calibrated) indicates an early Mesilla-phase affiliation. This date also appears appropriate to the undecorated brownwares to the south. Only seven lithic artifacts were recovered, and these did not shed any further light upon the dating of the site's occupation(s). Preservation conditions at the site were poor, and the recovered biological remains provided little information on subsistence patterns associated with the site. LA 115256 appears to be a very small-scale, short-term campsite utilized during the early Mesilla phase.

**LA 115259**

This is a small, apparently multicomponent site situated on the bajada slope of the Jarilla



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Mountains just north of Orogrande, within a dense concentration of archaeological sites. The testing identified eight thermal features, although only three were located within the right-of-way and only one of these (Feature 7) had any subsurface depth. No diagnostic artifacts were recovered from this large thermal feature, but a two-sigma, calibrated radiocarbon date of A.D. 350–440 indicates an early Mesilla-phase affiliation. A cluster of El Paso Brown sherds was documented outside the right-of-way, some distance from Feature 7, and supports evidence for a Mesilla-phase presence at the site. Some of the archaeological remains observed outside the right-of-way were buried under alluvium (exposed in arroyos), in stratigraphic contexts that suggest they date from Archaic times, although no diagnostic artifacts were observed to support this inference. LA 115259 was apparently a small campsite with both Archaic and Formative components. These occupations may have been linked to those at nearby sites, such as Orogrande North (LA 128708), which is located on the other side of US 54.

**LA 115260**

This occupation site lies within a small playa on the desert floor, just south of the Jarilla Mountains. Investigations at the site uncovered a buried midden deposit, along with a variety of features including both thermal and non-thermal pits, and two caliche-plastered floors that were only partially exposed. Ceramics from the site include both El Paso Polychrome and Bichrome, but there was no Chupadero Black-on-white, and the assemblage suggests an early Doña Ana-phase affiliation. This is potentially supported by three radiocarbon dates from the site.

Along with the ceramics, the site produced a substantial lithic assemblage. The debitage is consistent with the Late Formative affiliation for the site; silicified shale dominates the assemblage, although it occurs in a lower proportion than at the Jaca site (LA 6829), just 3 km to the north. Only four projectile points were recovered and, surprisingly, only one was a late prehistoric arrow point, with the three others consisting of Late Archaic types. A small amount of groundstone tools was recovered at the site, including five metates/grinding slabs, two manos, and two hammerstones.

LA 115260 was one of the few sites in the US 54 project where preservation conditions were good, and a rich assemblage of botanical remains was recovered including macrobotanical specimens, pollen, and phytoliths. Maize was present in both the macrobotanical and phytolith remains, although no maize pollen was identified. Other plant remains include locally occurring weeds and wood fuels, including several edible plants that were probably deposited at the site as a result of subsistence activities. This site also yielded the largest faunal assemblage of all the US 54 sites. The identifiable remains are overwhelmingly dominated by jackrabbit, even more so than at the nearby Jaca site, the only other site to yield a substantial faunal assemblage.

This site was a small, but intensively occupied habitation that apparently included structures with plastered floors. Although the occupation does not appear to have covered a great length of time, it was sufficiently intensive that an ashy midden deposit accumulated here. Interestingly, this midden accumulated during a period of rapid eolian deposition at the site, which is unusual because it indicates the site occupation occurred on a geomorphologically unstable surface. LA 115260 is also unusual for the Doña Ana phase in that it is situated on the desert floor *and* it contains evidence of substantial structures and agricultural production. This small site may have been part of a dispersed settlement that included nearby site LA 115265, which is located on the opposite side of US 54 in the same small playa, and also appears to date from the early Doña Ana phase.

**LA 115262**

This is the southernmost of the US 54 data recovery sites. It lies on the desert floor, on a low ridge surrounded by three playa-like depressions. It was occupied during the Late Archaic period



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and Mesilla phase, with the Late Archaic occupation including both Fresnal- and Hueco-phase components. Thermal pits and FCR/BC concentrations were the only feature types associated with the Late Archaic occupation. Of the three Late Archaic radiocarbon dates obtained from this site, one falls within the Fresnal phase while the other two fall within the subsequent Hueco phase.

The Mesilla phase component at LA 115262 included both extramural thermal features and one, possibly two, small pithouses. The one definite pithouse, Structure 1, was a shallow basin containing a simple, informal hearth. Although no ceramics were recovered from the fill of this small structure, it did yield a two-sigma, calibrated radiocarbon date of A.D. 230–550. One other, possible pithouse (Structure 2) was inferred from a tight clustering of pits and postholes, along with a concentration of artifacts at this locality. The features are assumed to be sub-floor pits and postholes surviving beneath a house basin that was completely obliterated by deflation. No radiocarbon date was obtained from these features, but the presence of undecorated brownware ceramics in some of them suggests a Mesilla-phase affiliation. One sherd recovered at this locality may be from a Playas Red Incised vessel, and so this inferred structure may date from the very late Mesilla or even Doña Ana phase. This sherd was found on the deflated surface above the presumed sub-floor features, however, and so it could well be from a later occupation. Although Structure 2 may have been larger than Structure 1, both are very small by Mesilla phase standards, even for desert-floor sites.

Situated in the middle of the basin floor, the occupants of LA 115262 lacked easy access to lithic sources. As a result, they substituted large quantities of caliche for use in their hearths and pit ovens (see Chapter 30). Ground stone fragments were also recycled for use as heating elements in thermal features.

LA 115262 appears to be typical of seasonal, basin-floor sites occupied during the late Archaic period and Mesilla phase (see Chapter 3). According to prevailing settlement models, these basin floor sites were most frequently occupied during the summer months, when monsoonal rains resulted in peak production of plant foods and other biological resources. At LA 115262, the adjacent playas probably provided at least temporary water sources following summer downpours. Unfortunately, preservation conditions at LA 115262 were not good, and the assemblage of biological remains was impoverished and not very informative as to subsistence activities associated with the site's occupations. The presence of heavy groundstone artifacts that were transported to the site, along with at least one pithouse (and possibly two) in the Mesilla-phase component, suggests the site was more than just an ephemeral camp, and that multiple occupations were anticipated.

#### LA 115263

This is a very small site located in a shallow desert floor depression, and only a few artifacts were exposed on the surface. Data recovery excavations documented a single, subsurface thermal feature. No diagnostic artifacts were recovered, nor were any radiocarbon samples processed, and so the temporal affiliation of this site remains unknown. Based on geomorphological evidence, the site probably dates from Late Archaic or Early Formative times. The site was obviously a very small-scale, short-term camp, although the presence of groundstone artifacts suggests an investment in the site occupation and at least anticipated re-use of this locality.

#### LA 115265

This site is situated in the same basin-floor depression as LA 115260, which lies on the opposite side of US 54. Past construction of the former US 54 had impacted this site heavily, but the testing phase identified discrete concentrations of ceramics and other artifacts, and data recovery excavations documented three subsurface thermal features within one of these concentrations. One of these, Feature 1, was a highly oxidized thermal pit similar to sub-floor hearths found in structures



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within the region. Accordingly, it is likely that there was a structure at this locality, and if so its remains (and perhaps those of other structures at the site) had been destroyed during previous construction of Old US 54.

Like nearby site LA 115260, the ceramic assemblage included El Paso Bichrome and Polychrome, but no Chupadero Black-on-white. Accordingly, an early Doña Ana phase affiliation is inferred for this site. A single radiocarbon date of A.D. 870–1220 (two-sigma, calibrated) was obtained from Feature 1.

Along with the Jaca site (LA 6829) and LA 115260, LA 115265 was one of the few US 54 sites where preservation conditions were good, and informative biological remains were recovered. These include a high percentage of maize, which was recovered from both macrobotanical and phytolith samples.

LA 115265 may have been part of a dispersed community that included nearby site LA 115260. As noted above, the desert-floor setting is unusual for Doña Ana phase sites with evidence of substantial agriculture and architecture. The playa location may have been selected for its seasonal availability of water (even if only for short periods following rains) and elevated soil moisture that probably made agriculture possible at this location. Insofar as this scenario is true, this situation resembles Mesilla-phase settlement strategies more closely than Doña Ana or El Paso phase patterns, with agricultural sites in the latter phases concentrated along the basin margins and alluvial fans.

#### LA 126181

This habitation site lies on the bajada apron of the Jarilla Mountains, north of Orogrande. Investigations here documented Formative period remains including both Mesilla and Doña Ana phase components. Although no structure remains were uncovered at this site, two middens, composed mostly of densely concentrated ceramic sherds, were documented. One of these middens occurred within the right-of-way, and excavations revealed it to be largely deflated and shallow. Nevertheless, 21 subsurface, cultural features were excavated within the right-of-way, all but one of which were thermal pits (the single exception was a non-thermal pit). The investigations recovered more than 1,000 ceramic sherds, mostly from the investigated ceramic sheet midden. The midden assemblage suggests a Doña Ana phase affiliation; El Paso Polychrome and Bichrome, along with Chupadero Black-on-white, are present, but there are no clear examples of undecorated El Paso Brown. Outside the midden, a single El Paso Brown sherd was recovered from a thermal pit that also yielded a radiocarbon date of A.D. 390–630 (two-sigma, calibrated). Two other features also yielded early to middle Mesilla phase dates, and another pit produced a late Formative date that falls primarily within the Doña Ana phase, although none of these three features yielded any ceramics or other diagnostic artifacts.

In contrast to the relative rich ceramic assemblage, LA 126181 yielded very few lithic artifacts including no groundstone items. Preservation conditions were poor, and the recovered biological remains were not very informative as to the subsistence activities associated with the site's occupations. LA 126181 is curious, in that it appears to represent a limited activity site, although the ceramic middens indicate that some activity episodes were especially intensive, producing large quantities of trash.

#### Orogrande 1 (LA 128699)

In terms of features and other archaeological remains, this was the second most productive of the US 54 sites, after Jaca (LA 6829). Along with adjacent sites Orogrande 2 (LA 128700) and LA 128701, Orogrande 1 is located at the juncture of two alluvial fans on the flanks of the Jarilla Mountains, and thus was positioned to take advantage of precipitation runoff that converges here. Investigations at Orogrande 1 identified 119 features, and both Late Archaic and Mesilla phase components were present. Most of the Late Archaic remains date from the Fresnal phase, while a smaller Hueco phase occupation is evi-



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denced as well. This is supported by a series of 12 Late Archaic radiocarbon dates, all but one of which falls within the Fresnal phase, and these dates cover a lengthy span of time within this phase. The Fresnal phase component includes the earliest structure documented among the US 54 sites. This small, simple pithouse (Structure 3) is very similar in size and character to structures excavated at the contemporary Keystone Dam site in El Paso (see Chapter 3). Otherwise, the Late Archaic component includes mostly thermal features and other remains distributed throughout the site.

The Mesilla phase component at Orogrande 1 is concentrated primarily in the northern portion of the site. Here, remains of four, tightly clustered, simple pithouses were uncovered (Structures 1, 2, 4, and 5). Of these, Structure 2 was completely excavated, and most of Structure 1 was uncovered, while only very small portions of Structures 4 and 5 were exposed (these structures all occurred at or near the northern edge of the impact area). Structures 1 and 2 were rectangular and oval in plan, respectively, and Structure 2 sported an entry ramp or ventilator that extended off its eastern side. Both structures contained simple, interior hearths, and Structure 1 contained additional pits and a possible posthole (although the latter feature may have been intrusive). Radiocarbon dates from these two structures are nearly identical (A.D. 610–880 and A.D. 620–880; two-sigma, calibrated), and indicate a middle Mesilla-phase affiliation. Undecorated brownware sherds from these structures and the vicinity support this temporal placement. Although these structures are larger than the Mesilla-phase pithouses at LA 115262, all of them fall within the smaller end of the size range for pithouses dating from this phase. Besides the four structures, the Mesilla phase component at Orogrande 1 includes extramural thermal features and a scattering of ceramics across the northern portion of the site. Ten of the radiocarbon dates from the site fall within the Formative period, and seven of these range within the early and middle portions of the Mesilla phase. The calibrated spans of the other three Formative dates fall primarily within the late Mesilla and Doña Ana phases, although no decorated ceramics were recovered that would corroborate these most recent dates from the site.

Lithic utilization and technology at Orogrande 1 reflects both the heavy Archaic presence at the site, as well as recycling of waste debris by the later, Formative-period occupants. The debitage assemblage was dominated by chert, which is typical of Late Archaic raw material use within the project area. Preservation conditions at the site were not especially good, and the recovered plant remains shed little light upon subsistence activities relating to the site's occupation. Lipid residues were recovered from eight pieces of FCR, however, and these indicate a variety of foods were processed in the site's numerous thermal features.

Although Orogrande 1 was a large, highly productive site, the occupational pattern here seems to be one characterized primarily by repeated, short-term encampments. Notable investments by the site's occupants include the construction of pithouses and heavy site furniture such as groundstone milling implements, and these indicate that at least some occupational episodes at the site consisted of more than brief stopovers.

**Orogrande 2 (LA 128700)**

Situated adjacent to Orogrande 1 (LA 128699), Orogrande 2 was located at the juncture of two alluvial fans on the flanks of the Jarilla Mountains. The site contained remains of both Late Archaic and Doña Ana-phase occupations, although both components appear to have involved small-scale and short-term encampments. There is also an historic component, most of the materials from which came from a discrete dump. The 24 excavated prehistoric features from the site were all thermal pits (or deflated remnants of thermal features); no structures or non-thermal pits were encountered. If structures were originally present at this site, they were either destroyed by erosion or were so ephemeral that they left no archaeological traces.



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The recovered artifact assemblage from the site included over 400 ceramic sherds and 646 lithics. The pottery includes El Paso painted and Chupadero Black-on-white vessels. The five El Paso Brown rims recovered were all thick with rounded or flattened lips, and as such are consistent with Late Formative, as opposed to Mesilla-phase forms. The lithic assemblage included only one diagnostic artifact—a Late Archaic projectile point of the Palmillas type. The debitage assemblage indicates both Archaic and Formative-period flaking activities at the site, with both chert and silicified shale present in substantial numbers, and distribution of these material types indicated some degree of spatial segregation between the two site components. The small ground stone assemblage included both manos and metates.

### Orogrande North (LA 128708)

This site was located on the upper bajada of the Jarilla Mountains, just north of the town of Orogrande. Testing investigations documented 34 features, and 47 discrete, surface artifact concentrations, but only five of these features were located within the right-of-way. Data recovery excavations documented an additional 16 features within the right-of-way, although only 15 cultural features here retained subsurface deposits. All were thermal features, and date from the Late Archaic period, Mesilla phase, and late Historic times. Of the 11 excavated, prehistoric features, eight were large thermal pits (i.e., > 70 cm in maximum diameter), and this was the highest ratio of large-to-small thermal pits documented at the US 54 sites (see Chapter 30).

Seven radiocarbon dates yielded calibrated determinations ranging from the early Late Archaic Fresnal phase (one sample), the late Late Archaic Hueco phase (three samples), and the middle portion of the Mesilla phase (two samples), plus one date that straddles the temporal boundary between the Hueco and Mesilla phases. The recovered artifact assemblage from this site was rather small, and included only 23 ceramic sherds. All of the sherds from the right-of-way were undecorated, El Paso Brownwares. Several decorated sherds, collected during the testing phase well outside the right-of-way, indicate later Formative occupations. The small debitage assemblage is dominated by silicified shale and heavy flakes, indicating flaking debris from the site dates primarily from the Formative period and reflects repeated, short-term occupancy of the site. The presence of heavy, ground stone milling implements suggests at least anticipated re-occupation.

The presence of large roasting pits at this site, and its location near the Jarilla Mountain uplands, initially led the investigators to suspect that this site was a specialized task locality, perhaps for processing succulents (such as agave). Unfortunately, biological remains were not well preserved, although lipid residues derived from two features (one Late Archaic and one Mesilla phase) did not support the succulent-processing hypothesis, but rather suggested a variety of foods may have been roasted at the site, including mesquite pods and prickly pear.

The historic component at Orogrande North was extensive, and includes a variety of features and other remains. Within the right-of-way, four small thermal features, all located in a discrete cluster, were documented. It is unclear whether these hearths date from the mining period associated with the nearby town of Orogrande, or are associated with the 1960s construction of US 54. Outside the right-of-way, mining-period historic remains include a segment of a pipeline that ran from the Brice Reservoir to the north, to the smelter site that lies just east of the site.

## Tested Sites

Eleven sites along US 54 were not investigated beyond the testing phase. Of these, nine were deemed not eligible to the NRHP, while two (LA 115255 and LA 128709) were eligible but were avoided by construction. The tested-only sites are distributed along the full length of the US 54 project corridor, and include desert floor, bajada, and upland settings. Three of these sites are prehistoric (LA 115255, LA 115257, and

LA 126178), six are historic (LA 110358, LA 115261, and LA 115264), and two contain both prehistoric and historic components (LA 128701 and LA 128709).

LA 115255 contained substantial prehistoric remains, including probable pithouse features. No ceramics were discovered here, although the chipped stone assemblage includes silicified shale, which is typically associated with Formative occupations within the project area. It seems likely that this basin-floor site includes both Archaic and Formative components. Redesign of the highway corridor here resulted in avoidance of this site.

Significant prehistoric remains were also documented at LA 128709, including 32 prehistoric features and ceramic and lithic artifacts. The site lies on the opposite (west) side of US 54 from Orogrande North (LA 128708), and for interpretive purposes the two sites should probably be considered as one. Only a small corner of LA 128709 will be impacted by the project construction activities; no features or other significant remains were encountered at this locality, and so data recovery efforts were not carried out at this site.

None of the other sites contained significant prehistoric remains, although LA 128701 did yield undecorated, brownware ceramics indicating a probable Mesilla-phase component. This site is situated between Orogrande 1 (LA 128699) and Orogrande 2 (LA 128700), and together with these sites forms a single site complex.

None of the historic remains encountered at any of the tested-only sites were considered eligible to the NRHP, although some of the sites in and around Orogrande did contain abundant historic remains or noteworthy features. Most of the historic debris at LA 115268, LA 128701, LA 128707, LA 128709, and LA 128710 dates from the mining period of Orogrande (i.e., the end of the nineteenth and early-twentieth centuries), and reflects a wide range of activities associated with the town. LA 115268 is a segment of the spur rail line that ran from the Orogrande station to the mines up in the nearby Jarilla Mountains. Although none of these individual historic components were deemed significant, a historic context for these remains and Orogrande was developed as part of this project (Chapter 32).

## Addressing the Research Issues

The research issues, identified in Chapter 4, are predicated in part upon current understanding of the cultural history in the central Jornada Mogollon region, and the special characteristics of the investigated sites themselves. The specific research domains identified include the following: chronology, resource variability and subsistence strategies, settlement and demographic patterns, regional interaction, and historic economic and social development.

### *Chronology*

Abundant chronological data were recovered from the project, including chronometric determinations and diagnostic artifacts, along with chipped stone debitage assemblages that could be dated relatively. For some sites, including Jaca (LA 6829), stratigraphic separation of archaeological remains provided additional chronological evidence. A total of 73 radiocarbon dates was obtained from 10 of the 11 data recovery sites. The radiocarbon results are presented in the respective site chapters, and are summarized here in Table 33.1. The dates helped to clarify the ages of the prehistoric components at these sites, and for some features provide the only temporal data available. The dates range from the early Late Archaic Fresnal phase to the Late Formative El Paso phase (Table 33.2), and no diagnostic materials were recovered to suggest prehistoric or protohistoric occupations outside this range. Of the 11 data recovery sites, only LA 115263 did not produce any specific chronological information, although geomorphological evidence suggested the few remains documented at this site probably date from Archaic times and/or the Mesilla phase (see Chapter 11).



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**Table 33.1 Radiocarbon Dates from the US 54 Project**

| LA No. | Feature | Feature Type | Beta No. | Material(s) Dated | Conventional Radiocarbon Age | Calibrated Date (2-sigma) |
|---|---|---|---|---|---|---|
| 6829 | 120 | Pit | 156949 | Charred Wood (Mesquite) | 680±60 | A.D. 1250–1410 |
| 6829 | 118 | Pit | 156945 | Charred Wood (Mesquite) | 700±60 | A.D. 1230–1400 |
| 6829 | 179 | Structure | 156956# | Charred Wood (Mesquite and fourwing saltbush) | 700±90 | A.D. 1180–1420 |
| 6829 | 111 | Structure | 156953 | Charred Wood (Mesquite) | 710±70 | A.D. 1200–1400 |
| 6829 | 46 | Thermal | 156936 | Charred Wood (Mesquite) | 750±60 | A.D. 1180–1310 and A.D. 1370–1380 |
| 6829 | 120 | Pit | 156947 | Charred Wood (Mesquite) | 750±70 | A.D. 1170–1320 and A.D. 1350–1390 |
| 6829 | 89 | Pit | 161834 | Charred Wood (Mesquite) | 760±70 | A.D. 1160–1310 and A.D. 1360–1390 |
| 6829 | 186 | Structure | 156957 | Charred Wood (Mesquite) | 780±60 | A.D. 1160–1300 |
| 6829 | 62 | Thermal | 156937 | Charred Wood (Mesquite) | 790±70 | A.D. 1050–1100 and A.D. 1140–1300 |
| 6829 | 86 | Pit | 156939 | Charred Wood (Mesquite) | 810±40 | A.D. 1170–1280 |
| 6829 | 85 | Thermal | 156941 | Charred Wood (Mesquite) | 810±40 | A.D. 1170–1280 |
| 6829 | 185 | Thermal | 156955 | Charred Wood (Mesquite) | 810±60 | A.D. 1050–1100 and A.D. 1140–1290 |
| 6829 | 146 | Structure | 161835 | Charred Wood (Mesquite) | 810±60 | A.D. 1050–1100 and A.D. 1140–1290 |
| 6829 | 178 | Thermal | 156951 | Charred Wood (Mesquite) | 830±80 | A.D. 1020–1300 |
| 6829 | 83 | Pit | 156954# | Charred Wood (Mesquite) | 840±70 | A.D. 1030–1290 |
| 6829 | 17.1 | Pit | 156950# | Charred Wood (Mesquite) | 850±60 | A.D. 1030–1280 |
| 6829 | 41 | Thermal | 156935 | Charred Wood (Mesquite) | 860±80 | A.D. 1010–1290 |
| 6829 | 95 | Thermal | 156944# | Charred Wood (Mesquite and unidentified wood) | 890±60 | A.D. 1020–1270 |
| 6829 | 54.13 | Posthole | 156946 | Charred Wood (Mesquite) | 890±60 | A.D. 1020–1270 |
| 6829 | 54.16 | Pit | 156948 | Charred Wood (Mesquite) | 890±60 | A.D. 1020–1270 |
| 6829 | 38 | Structure | 156938# | Charred Wood (Mesquite and unidentified wood) | 960±90 | A.D. 900–1260 |
| 6829 | 54.2 | Posthole | 156943 | Charred Wood (Mesquite) | 1010±50 | A.D. 960–1160 |
| 115256 | 3 | Thermal | 156959 | Charred Wood (Mesquite and unidentified wood) | 1610±60 | A.D. 330–580 |
| 115259 | 7 | Thermal | 156958 | Charred Wood (Mesquite and unidentified wood) | 1650±30 | A.D. 350–440 |
| 115260 | 1 | Midden | 161833* | Charred Wood (Mesquite) | 970±40 | A.D. 1000–1170 |
| 115260 | 1 | Midden | 161836* | Charred Wood (Mesquite) | 1000±50 | A.D. 970–1160 |
| 115260 | 1A | Pit | 156960# | Charred Wood (Mesquite) | 1230±90 | A.D. 650–1000 |
| 115262 | 1.1 | Thermal | 156962 | Charred Wood (Mesquite) | 1660±70 | A.D. 230–550 |
| 115262 | 2 | Thermal | 156963# | Charred Wood (Mesquite, 1 purslane seed, and unidentified wood) | 2040±110 | B.C. 370–A.D. 220 |
| 115262 | 24 | Thermal | 156961 | Charred Wood (Mesquite and cf. mesquite) | 2310±70 | B.C. 520–200 |
| 115262 | 4 | Thermal | 156964 | Charred Wood (Mesquite) | 3760±60 | B.C. 2340–2010 |
| 126181 | 24 | Thermal | 156968 | Charred Wood (Mesquite) | 810±60 | A.D. 1050–1100 and A.D. 1140–1290 |
| 126181 | 15 | Thermal | 156969# | Charred Wood (Mesquite) | 1550±60 | A.D. 400–640 |
| 126181 | 7 | Thermal | 156967 | Charred Wood (Mesquite) | 1560±60 | A.D. 390–630 |
| 126181 | 15 | Thermal | 156969# | Charred Wood (Mesquite) | 1550±60 | A.D. 400–640 |
| 126181 | 7 | Thermal | 156967 | Charred Wood (Mesquite) | 1560±60 | A.D. 390–630 |
| 126181 | 4 | Thermal | 156966 | Charred Wood (Mesquite) | 1590±80 | A.D. 260–640 |

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**Table 33.1 Radiocarbon Dates from the US 54 Project (continued)**

| LA No. | Feature | Feature Type | Beta No. | Material(s) Dated | Conventional Radiocarbon Age | Calibrated Date (2-sigma) |
|---|---|---|---|---|---|---|
| 128699 | 87 | Thermal | 161808 | Charred Wood (Mesquite) | 810±60 | A.D. 1050–1100 and A.D. 1140–1290 |
| 128699 | 79 | Thermal | 161809# | Charred Wood (Mesquite) | 870±90 | A.D. 1000–1290 |
| 128699 | 104 | Thermal | 161817 | Charred Wood (Mesquite) | 1120±60 | A.D. 780–1020 |
| 128699 | 26 | Thermal | 161800 | Charred Wood (Mesquite) | 1310±70 | A.D. 620–880 |
| 128699 | 23 | Thermal | 161799 | Charred Wood (Mesquite) | 1330±70 | A.D. 610–880 |
| 128699 | 83 | Thermal | 161805 | Charred Wood (Mesquite) | 1420±60 | A.D. 540–690 |
| 128699 | 81 | Thermal | 161803* | Charred Wood (Mesquite) | 1490±40 | A.D. 460–480 and A.D. 520–650 |
| 128699 | 82 | Thermal | 161804* | Charred Wood (Mesquite) | 1550±40 | A.D. 420–610 |
| 128699 | 78 | Thermal | 161815# | Charred Wood (Unknown tuberculate root) | 1630±100 | A.D. 220–640 |
| 128699 | 31 | Thermal | 161802* | Charred Wood (Mesquite) | 1650±40 | A.D. 330–460 and A.D. 480–520 |
| 128699 | 33 | Thermal | 161801* | Charred Wood (Mesquite) | 2010±50 | B.C. 160–A.D. 90 |
| 128699 | 3 | Thermal | 161796* | Charred Wood (Mesquite) | 3010±40 | B.C. 1390–1120 |
| 128699 | 43 | Pit | 161807* | Charred Wood (Mesquite) | 3490±40 | B.C. 1910–1700 |
| 128699 | 70 | Thermal | 161814* | Charred Wood (Mesquite) | 3490±40 | B.C. 1910–1700 |
| 128699 | 47 | Thermal | 161819 | Charred Wood (Mesquite) | 3520±60 | B.C. 2010–1690 |
| 128699 | 98 | Thermal | 161811 | Charred Wood (Mesquite) | 3580±60 | B.C. 2130–2080 and B.C. 2060–1760 |
| 128699 | 25 | Thermal | 161797* | Charred Wood (Mesquite) | 3600±50 | B.C. 2120–2090 and B.C. 2050–1870 and B.C. 1840–1780 |
| 128699 | 20 | Thermal | 161798 | Charred Wood (Mesquite) | 3600±80 | B.C. 2190–2170 and B.C. 2150–1740 |
| 128699 | 92 | Thermal | 161818 | Charred Wood (Mesquite) | 3610±60 | B.C. 2140–1770 |
| 128699 | 43 | Structure | 161806* | Charred Wood (Mesquite) | 3660±40 | B.C. 2140–1920 |
| 128699 | 38 | Thermal | 161810* | Charred Wood (Mesquite) | 3720±40 | B.C. 2210–2010 |
| 128699 | 102 | Thermal | 161816* | Charred Wood (Unknown tuberculate root) | 3750±50 | B.C. 2300–2020 |
| 128699 | 55 | Thermal | 161812* | Charred Wood (Mesquite) | 3750±60 | B.C. 2330–1970 |
| 128699 | 58 | Thermal | 161813 | Charred Wood (Mesquite) | 3870±60 | B.C. 2480–2140 |
| 128700 | 33 | Thermal | 161820 | Charred Wood (Mesquite) | 820±50 | A.D. 1060–1080 and A.D. 1150–1280 |
| 128700 | 43 | Thermal | 161824 | Charred Wood (Mesquite) | 860±60 | A.D. 1030–1280 |
| 128700 | 38 | Thermal | 161821 | Charred Wood (Mesquite) | 900±60 | A.D. 1010–1260 |
| 128700 | 44 | Thermal | 161825 | Charred Wood (Fourwing saltbush) | 1040±60 | A.D. 890–1060 and A.D. 1080–1150 |
| 128700 | 29 | Thermal | 161822* | Charred Wood (Mesquite) | 1170±50 | A.D. 720–740 and A.D. 760–990 |
| 128700 | 35 | Thermal | 161823* | Charred Wood (Mesquite) | 1790±40 | A.D. 130–350 |
| 128708 | 44 | Thermal | 161830 | Charred Wood (Mesquite) | 1270±70 | A.D. 650–900 |
| 128708 | 42.1 | Thermal | 161829 | Charred Wood (Mesquite) | 1360±70 | A.D. 570–790 |
| 128708 | 49 | Thermal | 161832# | Charred Wood (Mesquite) | 1810±60 | A.D. 70–380 |
| 128708 | 45 | Thermal | 161831* | Charred Wood (Unknown tuberculate root) | 1960±40 | B.C. 40–A.D. 120 |
| 128708 | 2 | Thermal | 161826 | Charred Wood (Fourwing saltbush) | 2000±60 | B.C. 160–A.D. 120 |
| 128708 | 39 | Thermal | 161827# | Charred Wood (Mesquite) | 2400±80 | B.C. 790–360 |
| 128708 | 41 | Thermal | 161828 | Charred Wood (Mesquite) | 2900±70 | B.C. 1300–900 |

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**Table 33.2 Distribution of Prehistoric Temporal Components at the US 54 Data Recovery Sites**

| Period | Late Archaic | | Formative | | | |
|---|---|---|---|---|---|---|
| Phase | Fresnal | Hueco | Early-Mid Mesilla | Late Mesilla | Doña Ana | El Paso |
| LA Site | | | | | | |
| 6829 | x | | | | X | X |
| 115256 | | | X | | | |
| 115259 | | | X | | | |
| 115260 | x | | | o | X | |
| 115262 | X | X | X | | | |
| 115265 | | | | | X | |
| 126181 | | | X | | X | |
| 128699 | X | X | X | o | | |
| 128700 | | | X | X | X | |
| 128708 | X | X | X | x? | x | x? |

X = radiocarbon dates and diagnostic artifacts
x = diagnostic artifacts only
o = radiocarbon dates only

Many of the Late Formative calibrated dates are somewhat imprecise given multiple intercepts along the calibration curve, typical of radiocarbon dates within this time range. In an attempt to obtain more precise determinations, archaeomagnetic samples were obtained from hearth features at the Jaca site. Unfortunately, however, these samples could not be successfully processed (see Appendix I). For the Jaca site, where the precision problem with the radiocarbon dates was especially critical, ceramics and stratigraphy were used (in conjunction with the radiocarbon evidence) to further refine the site's chronology. By combining these data, and considering the two-sigma overlaps among the calibrated dates from this site, a rather detailed occupational sequence could be proposed for this site. These same data further suggest that A.D. 1250, rather than A.D. 1200, is probably a more appropriate beginning date for the El Paso phase.

## Resource Variability and Subsistence Strategies

The quality and abundance of evidence relating to subsistence patterns varied among the US 54 sites, primarily as a result of preservation conditions. A total of 165 botanical samples were submitted for analysis, including macrobotanical remains and pollen and phytolith samples (Table 33.3). In general, the sites fell out into two groups. At Jaca (LA 6829), LA 115260, and LA 115265, preservation conditions were good, and these sites all yielded informative botanical assemblages with relatively high diversity of taxa. All three of these sites yielded maize macrobotanical specimens and phytoliths, with maize pollen recovered from Jaca. Jaca also yielded bean macrobotanical remains and phytoliths, and bean phytoliths were also recovered from LA 115265. In addition, Jaca yielded macrobotanical remains of a cultivated gourd.

**Table 33.3 Numbers of Botanical Samples Submitted for Analysis, by Data Recovery Site and Assemblage Category**

| Site | Macrobotanical Samples (Flotation) | Pollen Samples | Phytolith Samples | Totals |
|---|---|---|---|---|
| LA 6829 | 29 | 22 | 8 | **59** |
| LA 115256 | 2 | | 1 | **3** |
| LA 115259 | 1 | | | **1** |
| LA 115260 | 5 | 4 | 2 | **11** |
| LA 115262 | 12 | 1 | | **13** |
| LA 115263 | 1 | | 1 | **2** |
| LA 115265 | 2 | | 1 | **3** |
| LA 126181 | 6 | 2 | 1 | **9** |
| LA 128699 | 28 | 14 | | **42** |
| LA 128700 | 6 | 5 | | **11** |
| LA 128708 | 6 | 5 | | **11** |
| **Totals** | **98** | **53** | **14** | **165** |

No evidence of cultigens, and only low diversities of taxa, were recovered from the other eight data recovery sites. None of the sites yielded cultigens. The results thus leave us with evidence of domesticated plant use and agriculture at only three sites, all of which date from Late Formative times. Although domestication and agriculture have been previously documented for the Late Archaic period and Mesilla phase in the Jornada Mogollon region, no such evidence was recovered

from the US 54 sites. Again, preservation factors might be implicated here. The results were especially disappointing with respect to Orogrande 1 (LA 128699), which contained a substantial Late Archaic component. Numerous samples were collected and processed from this site in the hopes that detailed subsistence information, including evidence for early use of maize, could be recovered from this site.

In addition to rich floral assemblages, Jaca and, especially, LA 115260 also produced substantial quantities of faunal remains. These indicated an overwhelming reliance on jackrabbit for meat-derived protein, with slightly higher frequencies for cottontail and artiodactyls at Jaca. The differences, however slight, may be symptomatic of Jaca's location, closer to an upland zone (i.e., the Jarilla Mountains), where artiodactyls and cottontails have occurred with higher frequency than out on the basin floor.

Lipid residues were also recovered from pieces of fire-cracked rock and ceramic sherds in an attempt to shed additional light on subsistence patterns (see Chapter 28). Although specific species could not be identified from these residues, the samples indicated a wide variety of both plant and animal foods were prepared in the many pit ovens excavated at the sites.

With this summary of subsistence evidence at hand, we can now address the specific, subsistence-related research questions posed in Chapter 4. Concerning the Late Archaic, these questions included the following:

***Are Late Archaic components with preserved subsistence remains present at some of the US 54 sites?***

***What is the range of plants utilized by Late Archaic groups who may have occupied the targeted sites?***

***Were these plants locally available?***

***Is there evidence of domesticated plants in Archaic components in the US 54 sites?***

***Is there evidence of Late Archaic maize farming at any of the targeted sites, and if so, what was the role of maize in the local subsistence economy at that time?***

Potential subsistence remains were recovered from Late Archaic components, but in general plant remains associated with these occupations were not well preserved. No cultigens were identified in any of the Late Archaic components. In general, the US 54 project contributes little direct evidence regarding Late Archaic subsistence patterns.

The research design also posed the following, general questions:

***What subsistence patterns were associated with the Jornada Mogollon occupations of the targeted sites?***

***What are the roles of cultivated plants in the various Jornada Mogollon occupations within the targeted sites?***

***Is there evidence for horticultural activities in the Mesilla phase components?***

In general, the evidence suggests that Late Archaic and Mesilla-phase occupations at the US 54 sites were focused heavily on hunting and gathering, while the Late Formative occupations involved substantial agricultural production (especially maize farming), along with exploitation of wild food resources. There is no evidence of cultivated plants in the Late Archaic and Mesilla-phase components.

The following questions regarding task-specific subsistence activities were also posed:

***Is there any evidence of task-specific subsistence activities at the smaller Jornada Mogollon sites, such as agave collecting/roasting or procurement and/or processing of other localized plant or animal resources?***

***If there is evidence of task-specific subsistence activities at the smaller sites, are these activities related, as part of an integrated subsistence-set-***



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***tlement system, to the occupations at the larger sites?***

***Alternatively, do the larger sites also contain evidence of task-specific subsistence activities, which might in turn suggest that the smaller sites mark activities by comparably small, independent (and possibly chronologically discrete) groups?***

Very little clear evidence of task-specific occupations emerged from the project results. The occupation at Jaca, where the best subsistence data were recovered, obviously involved a residential settlement that included a wide range of tasks. In Chapter 30, we examined numbers and ratios of pit features, specifically small vs. large thermal pits and thermal pits vs. non-thermal ones. At Orogrande North (LA 128708), there was an unusually high ratio of large to small thermal features (the former are generally assumed to be roasting pits, and the latter hearths). This initially led us to suspect that this site, located high on the Jarilla Mountains bajada, might have been a specialized, agave-roasting locality. Although the botanical data shed little light on this question, recovered lipid residues indicated a variety of foods were processed in the earth ovens at this site, and there was no clear evidence of agave roasting.

Relating the large and small sites to each other proved difficult. One of the large sites, Orogrande 1 (LA 128699), actually appeared to be a palimpsest of many small occupations, dating from both the Late Archaic period (primarily Fresnal phase) and Mesilla phase. Thus, the individual occupations at this site were probably very similar to those at the smaller, Late Archaic and Early Formative components encountered elsewhere. Interesting, the Late Formative components include both intensive residential occupations (Jaca, LA 115260, and, possibly, LA 115265), and smaller, less substantial ones (Orogrande 2 and LA 126181). How these sites may have related to each other within the local subsistence-settlement systems remains largely an open question. LA 115260 (and probably nearby LA 115265) appear to pre-date the main occupation at Jaca (LA 6829), and so these sites, at least, do not appear to be related.

Finally, two subsistence-related questions were posed that refer to non-botanical data.

***What is the role of faunal resources in the Archaic and Jornada Mogollon diet?***

***From which ecological niches and from what distance are these resources coming from?***

Informative faunal remains were recovered from Jaca (LA 6829) and LA 115260 only. Both are Late Formative sites, and the animal bone assemblages indicate heavy reliance on local resources (principally jackrabbit), with little evidence of non-local meat procurement. The Jaca assemblage did reveal slightly higher proportions of cottontail and artiodactyls, which may be symptomatic of this site's closer proximity to the Jarilla Mountains relative to LA 115260.

***Do changes in the size of manos and metates (and their grinding surfaces) from the targeted sites match patterns noted elsewhere, and what do these data reveal in terms of subsistence patterns?***

Variation in mano size was documented at the project sites (see Chapter 21), with two-handed manos recovered at the Jaca site (LA 6829) only. This is consistent with other evidence indicating intensive agriculture and maize production associated with this site's occupation. Jaca also contained one-hand manos, however, and this type of mano was recovered at other US 54 sites. The mano data suggests a heavy reliance on wild plant foods at the Late Archaic and Mesilla-phase occupations, while the inhabitants at Jaca were processing both maize and wild foods. Recovered metates were generally very fragmentary, and not very informative regarding subsistence patterns. It should be noted, however, that no clear examples of trough metates were recovered, with the identified specimens including only basin and slab forms.



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### *Settlement and Demographic Patterns*

The data recovery efforts at the US 54 sites were not part of a research project focused on settlement patterns, although the occupations of these sites were obviously part of broader land use and mobility strategies that varied over both time and space. In terms of regional demographic patterns, the range of components generally reflects broader trends across the region. The absence of recognizable Paleoindian, Early Archaic, Middle Archaic, and protohistoric components in the investigated sites is symptomatic of the low population densities, highly mobile lifeways, and low-visibility archaeological remains that characterize these periods. Archaeological visibility in the investigated sites begins to spike with the Late Archaic period, with components containing features present at four of the 11 data recovery sites (see Table 33.2, above). This accords with other evidence suggesting that regional population levels experienced a sharp increase during Late Archaic times (see Chapter 3).

The subsequent early-middle Mesilla phase is the most ubiquitous temporal unit, present at seven of the data recovery sites. This is consistent with current survey evidence and settlement-demographic models for the region (e.g., Carmichael 1986; Whalen 1994a). These models suggest that population levels continued to climb sharply during the Mesilla phase, but that highly mobile, subsistence-settlement patterns remained generally similar to those of Late Archaic times. As a result, Mesilla phase components are both numerous and distributed widely across the landscape. Moreover, the appearance of ceramics makes Mesilla-phase components more visible archaeologically than Late Archaic ones. Thus, it is not surprising that the US 54 corridor encountered a relatively high number of Mesilla-phase sites. Interestingly, however, the late Mesilla phase is not well represented among the project sites. This may be due simply to the random, hit-or-miss results along this linear project area. It is also possible, however, that Mimbres Black-on-white pottery—a crucial diagnostic artifact for the later Mesilla and early portion of the Doña Ana phases—may not be present in large numbers within this portion of the central Jornada region. Mimbres Black-on-white was exceedingly rare in the recovered ceramic assemblages, and this issue should be evaluated further in future investigations in this area.

Following the Mesilla phase, population levels continued to rise, but settlement patterns became more restricted spatially, with sites concentrated along alluvial fans and basin margins. Nevertheless, the Doña Ana phase was well represented among the US 54 sites, with six (and possibly seven) components represented. This is the shortest phase in the central Jornada Mogollon sequence, and the high frequency of components among the US 54 sites underscores an apparently sharp increase in population levels at this time. In contrast to the relative ubiquity of Doña Ana-phase components, the El Paso phase is clearly represented only at the Jaca site, and this occupation appears to extend only into the very early portion of this phase.

In terms of site size, range of activities, and duration of occupation, the US 54 sites exhibit an appreciable degree of variation. The three well-documented Late Archaic components consist mostly of small and/or seasonally occupied camps, including two on the Jarilla Mountains bajada (Orogrande 1 and Orogrande North), and one on the interior basin floor (LA 115262). These sites contain mostly thermal features, although a small pithouse was documented at Orogrande 1. These settlements appear to represent repeatedly occupied, seasonal camps. Orogrande 1, with its large number of features, pithouse, and groundstone milling equipment, may have hosted larger groups than other Late Archaic sites did, or it may simply have been reoccupied many more times during the Late Archaic period.

Mesilla-phase occupations were well documented by the US 54 investigations. Most of the US 54 sites with Mesilla components occur on the Jarilla Mountains bajada (LA 115256, LA 115259,



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LA 126181, LA 128699, LA 128700, and LA 128708), with one site out on the basin floor (LA 115262). Like the Late Archaic occupations, most of these appear to be small-scale camps occupied seasonally or for only very short stints. Orogrande 1 and LA 115262 both contain Mesilla-phase structures, and these indicate a higher investment in the occupations at these sites than at the others. Nonetheless, the character of the investigated Mesilla-phase components seems to underscore the prevailing, high-mobility settlement-subsistence systems that characterize this phase.

The Doña Ana phase is also well represented among the US 54 sites, including sites on the Jarilla Mountains bajada (Jaca [LA 6829], LA 126181, and LA 128700) and the basin floor (LA 115260 and LA 115265). Two of the Doña Ana-phase components, LA 126181 and LA 128700, were considerably smaller and/or shorter-term occupations than those at Jaca and LA 115260. These occupations left mostly thermal features, although LA 126181 also contained two ceramic concentrations, at least one of which dates from the Doña Ana phase, indicating locally intensive cooking activities or ceramic production.

At least two of the Doña Ana-phase sites, Jaca (LA 6829) and LA 115260, are substantial, residential occupations. LA 115265, located near LA 115260, may also have been a substantial residential occupation, but previous construction of US 54 had badly damaged this site. The occupation at LA 115260 was smaller than the one at Jaca, but contained a midden deposit and dense concentration of features, including what appear to be the plastered floors of structures.

Jaca (LA 6829) was in a class by itself in terms of size, occupational intensity, numbers of features, and other cultural materials. This site was a substantial settlement and contained far and away the highest number of structures (18) of any of the sites. Surprisingly, most of these are small, informal pithouses, although the site also contains evidence of what might be one of the earliest attempts at room block construction in the central Jornada region. Jaca also contained numerous thermal features, including both hearths and roasting pits, and also the highest number of non-thermal pits, including some of the clearest examples of storage facilities (although these were not numerous at this site). Among the non-thermal pits were some exceptionally large, irregular features that are tentatively interpreted as water catchment facilities or *huecos*. Botanical evidence indicates the inhabitants of Jaca were farmers, growing substantial amounts of maize along with beans and gourd, and that they were probably farming on, or adjacent to, the site. Jaca is also the only US 54 site with a definite El Paso-phase component, although the occupation here extends only into the very early decades of this phase. The settlement evidence from Jaca presents a curious mix of indicators; while the small, informal pithouses would seem to suggest a high degree of seasonal mobility, the possible room block and evidence for agriculture indicates a more settled existence for at least some of the site's inhabitants. Lying at the foot of an alluvial fan, Jaca is also in a classic location for Late Formative agricultural sites.

Sites LA 115260 and LA 115265 are somewhat unusual in that they are located within a desert-floor playa. Nevertheless, the intensive occupations at Jaca and LA 115260/115265, and the botanical evidence for agricultural production from these sites, are consistent with previous evidence from the region for reduced mobility and the appearance of substantial residential sites and agriculture in the Doña Ana phase (see Chapter 3). Another indicator of reduced mobility was documented in the chipped stone debitage assemblages, with the Archaic components using higher-quality cherts, while the Formative-period inhabitants utilized more of the locally available, but poorer-quality silicified shale (see Chapter 21).

From this overview of the settlement data, we can offer responses to the settlement-related research questions posed in Chapter 4.



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***What is the range in terms of settlement types represented in the targeted sites, and how does the analysis of these sites enhance present understanding of settlement and sociopolitical trends in the region?***

The settlement types range from small, seasonally occupied camps, to much more intensively occupied, residential sites. The latter include only Late Formative components, whereas the former range from Late Archaic to Late Formative times. The results support existing models of settlement and sociopolitical trends in the region, which emphasize a reduction in mobility over time (especially following the early-middle Mesilla phase), and the emergence of larger, more integrated social groups. The latter trend was tempered, however, by the persistence of mobility options, involving both seasonal and periodic aggregation and dispersion, throughout the Late Formative period.

***What special characteristics of the local environment (including distance to water resources) had an impact on settlement patterns and the production of surpluses?***

Water is far and away the most critical resource in the arid Chihuahuan desert, and availability of water had a substantial influence on locations and patterning of the investigated sites. The three basin-floor sites are all located either next to playa depressions (LA 115262), or inside playas (LA 115260 and LA 115265). As such, these sites were situated so as to take advantage of scarce rainfall that would have accumulated in these basin-floor depressions. This would have been important not only for obtaining drinking water, but also for the enhanced soil moisture conditions in the playas that would have made agriculture possible and would also have produced a higher density of wild vegetation, including edible plants. All of the other US 54 data recovery sites are situated on the alluvial fans of the Jarilla Mountains. Here, precipitation runoff from the mountains would have enhanced availability of water. Three sites—Orogrande 1 (LA 128699), Orogrande 2 (LA 128700), and LA 128701—were located at the juncture of two alluvial fans flanking the Jarillas, and these sites were especially well positioned to take advantage of concentrated runoff.

***How do these sites compare with Whalen's settlement model?***

In general, the character of the investigated sites and their distribution pattern accord well with Whalen's model. Specifically, small sites occur on both the basin floor and on alluvial uplands, while Jaca (LA 6829), the largest and most intensive residential site investigated, occurs on the lower alluvial fan of the Jarilla Mountains. The only real surprise involved LA 115260 and LA 115265, which appear to be residential localities within a spatially dispersed settlement, and yielded evidence of agricultural production. These sites were located in a desert-floor playa, which is an unusual location for Late Formative residential sites.

***What can the smaller sites suggest in terms of mobility patterns over time?***

The small sites indicate a high degree of mobility throughout the Late Archaic period and Mesilla phase, and the maintenance of mobility options during the somewhat more sedentary, Late Formative period.

***Were some or all of the small sites used for task-specific functions relating to subsistence and/or lithic procurement activities, and if so, what tasks are represented?***

As discussed above under the subsistence-related questions, no clear evidence of task-specific functions were identified among the small sites. Some of these sites (e.g., LA 115256, LA 115259, and LA 115263), however, are so small and short-term that, obviously, their occupations involved a limited range of activities. Still, even at the smallest site, LA 115263, ground stone milling implements were recovered, suggesting this occupation was more than just a transitory camp, and that re-occupation was at least anticipated.



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***What is the local Doña Ana and El Paso phase settlement pattern, and how (if at all) do any of the small sites relate to large, residential occupations such as the one at the Jaca site (LA 6829)?***

Both low-density camps and more substantial residential sites were documented for the Late Formative period by the US 54 project. As explained under the section on subsistence, above, determining the precise relationships of these sites proved difficult at best, although temporal evidence does suggest non-contemporaneity between residential sites LA 115260 and LA 115265 on the one hand, and Jaca (LA 6829) on the other.

***If there are connections in terms of site functions and settlement pattern between the targeted sites, how does this relate to local and intra-site sociopolitical organization?***

Again, this question is difficult to address in detail from the recovered data. It is worth reiterating, however, that the presence of both large and small sites in Late Formative contexts underscores the continuation of some degree of seasonal mobility or periodic dispersion of local populations. The evidence may also indicate that some local groups carried on more mobile lifeways than others during the Late Formative, and that perhaps there were symbiotic relations between the two. At the very least, the evidence underscores the very dynamic, changing social relations both within and between Late Formative communities.

***What can excavations at LA 6829 tell about the process of pueblo establishment in the Doña Ana and El Paso phases, the architectural features of such sites, the occupational duration of local pueblo settlements, and abandonment processes?***

The Jaca site (LA 6829) yielded abundant evidence to address this question, including some surprises. As discussed in Chapters 6 and 31, and in the site summary presented earlier in this chapter, the probable room block represented by Structures 1 and 3 appears to be one of the earlier examples of pueblo construction in the central Joranada Mogollon region. The construction of a communal room (Structure 1) directly over a formal pithouse (Structure 2) indicates not only occupational continuity at the site, but also functional continuity between superimposed structures of different forms. Moreover, pueblo construction at Jaca occurred in the context of a settlement that otherwise consisted of small, informal pithouses, which were built and occupied before, during, and after construction of the room block. The preservation of a north-south spatial dichotomy of structures at the site (through all three occupation periods) also suggests the possible persistence of a moiety-like social division within this community. Social differences between these two clusters may be manifested in the Jaca 2 period, when the room block was constructed within the northern cluster, while simple pithouses were present in the southern cluster.

***What was the duration or intensity of site use during each temporal component?***

Again, most of the sites appear to consist of small, seasonally occupied camps, even the very large site of Orogrande 1 (LA 128699). Distinctly more intensive, longer-term occupations were documented at Jaca (LA 6829) and LA 115260. LA 115265, which had been badly damaged during earlier construction of US 54, was probably also an intensive occupation related to LA 115260.

***What was the population composition at each site and how does that relate to site function?***

This question proved difficult to answer, especially given that the investigations were restricted to portions of the sites scheduled for impact, leaving other portions unexplored. Most of the small sites appear to have hosted only a handful of individuals at any one time. At Orogrande 1 (LA 128699), somewhat larger groups may have been present at the site, at least periodically, and a small, short-lived hamlet of perhaps several contemporary households may have been established in the middle Mesilla phase. At Jaca (LA 6829), each of the three occupational periods included from three to eight households, but it remains



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unknown how many additional house remains might be present outside the right-of-way, or formerly present within the borrow pit.

### Regional Interaction

In Chapter 4, the following, general question was posed regarding this research issue:

***What evidence for regional exchange networks exists on the sites?***

Evidence for regional interaction come primarily from three data sources: ceramics, lithic material types, and a single, marine-shell artifact.

Patterns of regional interaction were documented primarily within the ceramic assemblages, and these are discussed in the respective site chapters and in Chapter 20. These findings were used to address the following research question:

***What can the analysis of ceramics tell about inter-regional interaction during the Formative period (especially the Doña Ana and El Paso phases), and are the observed patterns consistent with what is presently known about these patterns in the southern Tularosa Valley?***

Ceramic assemblages from the Jornada Mogollon region indicate sharply increased participation in extra-regional interaction spheres beginning in the late Mesilla phase, and continuing throughout the Late Formative period. The earliest ceramic type indicating extra-regional interaction among the US 54 sites is Alma Plain, which derives from the Mimbres Mogollon region to the west, and is a long-lived ceramic type in Mogollon prehistory. In the US 54 assemblage, Alma Plain was recovered from LA 115262 and the Jaca site (LA 6829) only. LA 115262 contains a Mesilla-phase component, whereas Jaca is a Late Formative site. The low incidence of Alma Plain in the project sites suggests that relatively few pottery vessels from the Mimbres area found their way into the project area.

The same appears to be true for Mimbres Black-on-white ceramics, which is one of the most prominent markers of extra-regional interaction in the late Mesilla and early Doña Ana phase. Like Alma Plain, Mimbres Black-on-white generally is assumed to have been imported from the Mimbres area to the west, although some local imitations may have been produced in the central Jornada region. At any rate, very little Mimbres Black-on-white was recovered from the US 54 sites, and two possibilities may explain this. First, Mimbres Black-on-white may not occur in substantial numbers in this portion of the Tularosa Basin. Second, perhaps very few of the remains encountered in the US 54 sites were left by either late Mesilla- or early Doña Ana-phase occupations. This possibility seems undercut by data recovered from LA 115260 and LA 115265, which appear to be part of an early Doña Ana phase occupation, judging from the complete absence of Chupadero Black-on-white.

Moving further into the Late Formative period, extralocal ceramic wares become more prevalent, and Chupadero Black-on-white is the most prominent of these. Generally considered to originate in the Salinas and Sierra Blanca regions, the high frequency and ubiquity of Chupadero Black-on-white in Jornada Mogollon, Late Formative sites indicates especially close ties to non-Jornada peoples north and northeast of the Tularosa Valley. NAA analysis of Chupadero Black-on-white sherds from the US 54 project suggest a Sierra Blanca origin for the analyzed sherds, but oxidation analysis indicates there may also be additional production localities for this prominent ware.

Other decorated wares are present in the early El Paso-phase component at the Jaca site (LA 6829). These include Casas Grandes series sherds (i.e., Playas Red and Playas Red Incised), which are generally considered to come from northern Mexico; and Cibola series ceramics (Banded gray, White Mountain types, and St. Johns painted wares), originating from areas to the northwest of the Jornada Mogollon region. The presence of these types is symptomatic of the expanding range of inter-regional interaction spheres participated in by Jornada Mogollon peoples.



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Analysis of lithic material types, discussed in Chapter 21, provided another avenue of investigation in regional interaction, and prompted the following question:

***What can lithic and other artifact classes reveal about patterns of regional interaction involving the past occupants of the targeted sites?***

The material types present in the assemblage indicated that most of those utilized were procured from the Tularosa Basin or the uplands along its margins. Still, a diachronic trend in material-type utilization patterns was identified, and is of potential relevance here. Specifically, during Late Archaic times, flintknappers tended to utilize chert and other relatively good-quality materials, and were willing to travel some distance to procure these types of chippable stone. In Formative assemblages, there is a sharp reduction in the frequency of chert, and an increase in the use of silicified shale, a presumably inferior material, but apparently available in abundance within the Jarilla Mountains. To what extent the reliance on non-local cherts and other higher-quality materials during Archaic times reflects the operation of regional interaction spheres, as opposed to simply the larger group territories and higher levels of mobility that likely prevailed at this time, remains an open question.

Compositional analysis of obisidian artifacts, presented in Chapter 22, was also undertaken in an attempt to explore patterns of regional interaction. Although the geological sources of the recovered obsidian were quite distant (principally Jemez Mountain sources), these materials are also available at much closer sources, specifically in the form of pebbles that occur in the Rio Grande gravels and, probably, the Camp Rice Formation in the southwestern Tularosa Valley. The size of the recovered obsidian artifacts was consistent with utilization of pebble-size materials, and it is assumed that they were procured from the not-so-distant gravel sources.

Finally, a single shell bead fashioned from the marine bivalve *Glycymeris gigantea* was recovered from the Jaca site. This species is found in the Gulf of California and further underscores the long-distance exchange networks that the Late Formative occupants of the Jaca site were linked to.

## Historic Economic and Social Development

Historic artifacts were recovered from several of the US 54 sites, especially those in and around the town of Orogrande. These artifacts are described in the respective site chapters, and a historical context for Orogrande is presented in Chapter 32. The research design posed several questions relating to the historical period in the project area, and these are addressed individually here.

***What historic time period(s) is (are) represented at the investigated sites in and around Orogrande?***

***If there are different time periods represented, can different functions be attributed to different periods of deposition through an examination of features and artifact classes?***

As expected, the documented historic artifacts date primarily from the late nineteenth through mid-twentieth centuries. Although several historic hearths were excavated at Orogrande North (LA 128708), these did not contain artifacts datable to a narrow time frame, and no other deposits or subsurface historic features were excavated. Many of the artifacts appeared to be in dumps or secondary contexts, removed from their original place of use and discard.

***Which of the industrial activities that occurred in and around Orogrande were identified from the historic sites, features, and artifacts?***

The most prominent remain associated with old Orogrande's industrial activities was the water line that ran from the Brice Reservoir to the smelter, which was formerly located just southeast of the site. This feature occurred outside of the right-of-way, however, and so it was only minimally documented.



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***What is the spatial relationship between targeted sites and the platted town, mines, ore processing facilities, or the railroad?***

The project sites occur primarily around the peripheries of Orogrande. LA 115258 was a segment of the old railroad grade that served the mining operations and associated settlements in the Jarilla Mountains. The Orogrande North site (LA 128708) was located next to the former smelter (see Chapter 32), and a old water line running from the Brice Reservoir to the smelter traversed the site, but was outside of the right-of-way.

***Can the identity of the complex north of LA 128709, visible in the northern portion of a 1941 aerial photograph, be determined from archival, and/or oral history investigations?***

According to Clif McDonald, an Orogrande historian with decades-old personal memories of the town and its mining district, this feature marks the site of a Civilian Conservation Corps (CCC) camp that operated here in the 1930s.

## Management Recommendations

Testing and data recovery were carried out at 22 sites along the US 54 corridor (Table 33.4). The data recovery program conducted at Jaca (LA 6829), LA 115256, LA 115259, LA 115260, LA 115262, LA 115263, LA 115265, LA 126181, Orogrande 1 (LA 128699), Orogrande 2 (LA 128700), and Orogrande North (LA 128708) recovered significant data pertaining to prehistoric occupations ranging from Late Archaic to Late Formative times. Investigations were restricted to portions of the sites within the US 54 right-of-way and associated impact areas. Data recovery was completed within the areas of these sites scheduled for impact, except for the Jaca site (LA 6829) core area, where the right-of-way was narrowed to protect cultural resources along the right-of-way periphery. The data recovery excavations exhausted the archaeological potential within the investigated portions of all sites, and the proposed construction activities will have no effect on cultural resources within these areas.

All of the data recovery sites, however, extend beyond the right-of-way and associated impact areas, and significant data potential (either probable or demonstrated) exists in non-investigated portions of these sites. At the Jaca site (LA 6829), the investigations demonstrated the presence of significant, subsurface archaeological features and/or other deposits in the uninvestigated portion of the site, and some of these remain protected within the re-aligned portion of the right-of-way. Important questions remain concerning the internal layout and precise chronology of the Late Formative settlement here.

Examination of arroyos outside the right-of-way at LA 115259 revealed subsurface archaeological remains that retain significant potential, including probable buried Archaic materials. Relatively little data were recovered from the narrow, right-of-way portion of the site, and further investigations here could shed considerable light on the full range of archaeological components at LA 115259.

At LA 115260, aborted excavations between the two right-of-way fences (an area excluded from construction activities) revealed especially rich, subsurface archaeological remains (including what appear to be plastered floors of structures), and measures were taken in the field to protect these resources (see Chapter 9). Further investigations into these features (and any other, as yet discovered ones here) would produce data that would significantly enhance our understanding of this very rich and important site, and contribute to a fuller picture of Doña Ana-phase developments in the area.

Accordingly, the status of sites LA 6829, LA 115259, and LA 115260 as eligible to the NRHP should be continued. Should any future, ground-disturbing activities, which would fall under appropriate regulations, be planned for these sites, such activities should be preceded by a data recovery plan that includes an initial phase to determine the extent and nature of cultural resources to be impacted.



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**Table 33.4 NRHP Eligibility Status and Management Summary for the US 54 Sites**

| Site | Investigations Conducted | NRHP Eligibility | Justification | Management Recommendations |
|---|---|---|---|---|
| LA 6829 | Testing & Data Recovery | Eligible | Demonstrated data potential (recovered & remaining) | Protection measures; further data recovery in the event of future construction |
| LA 110358 | Testing | Not Eligible | No demonstrated data potential | No further work or management measures |
| LA 115255 | Testing | Eligible | Demonstrated data potential | Site avoided by US 54 construction; data recovery in the event of future construction |
| LA 115256 | Testing & Data Recovery | Eligible | Demonstrated data potential (recovered); probable remaining potential | Protection measures; further testing in the event of future construction |
| LA 115257 | Testing | Not Eligible | No demonstrated data potential | No further work or management |
| LA 115258 | Testing | Not Eligible | No demonstrated data potential | No further work or management |
| LA 115259 | Testing & Data Recovery | Eligible | Demonstrated data potential (recovered & remaining) | Protection measures; further testing in the event of future construction |
| LA 115260 | Testing & Data Recovery | Eligible | Demonstrated data potential (recovered & remaining) | Protection measures; further testing in the event of future construction |
| LA 115261 | Testing | Not Eligible | No demonstrated data potential | No further work or management |
| LA 115262 | Testing & Data Recovery | Eligible | Demonstrated data potential (recovered); remaining potential highly likely | Protection measures; further testing in the event of future construction |
| LA 115263 | Testing & Data Recovery | Eligible | Demonstrated data potential (recovered); possible remaining potential | Protection measures; further testing in the event of future construction |
| LA 115264 | Testing | Not Eligible | No demonstrated data potential | No further work or management measures |
| LA 115265 | Testing | Eligible | Demonstrated data potential (recovered); possible remaining potential | Protection measures; further testing in the event of future construction |
| LA 126178 | Testing | Not Eligible | No demonstrated data potential | No further work or management measures |
| LA 126181 | Testing & Data Recovery | Eligible | Demonstrated data potential (recovered); probable remaining potential | Protection measures; further testing in the event of future construction |
| LA 128699 | Testing & Data Recovery | Eligible | Demonstrated data potential (recovered); remaining potential highly likely | Protection measures; further testing in the event of future construction |
| LA 128700 | Testing & Data Recovery | Eligible | Demonstrated data potential (recovered); probable remaining potential | Protection measures; further testing in the event of future construction |
| LA 128701 | Testing | Not Eligible | No demonstrated data potential | No further work or management measures |
| LA 128707 | Testing | Not Eligible | No demonstrated data potential | No further work or management measures |
| LA 128708 | Testing & Data Recovery | Eligible | Demonstrated data potential (recovered); remaining potential highly likely | Protection measures; further testing in the event of future construction |
| LA 128709 | Testing | Eligible | Data potential within uninvestigated portions of site | No significant resources w/in the US 54 impact area; further testing in the event of future construction |
| LA 128710 | Testing | Not Eligible | No demonstrated data potential | No further work or management measures |



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At LA 115256, LA 115262, LA 126181, Orogrande 1 (LA 128699), Orogrande 2 (LA 128700), and Orogrande North (LA 128708), the nature of surface features and other archaeological remains beyond the right-of-way and impact area boundaries indicated a high probability that significant, subsurface cultural resources remain in place on these sites. At LA 115263 and LA 115265, it is not as clear whether or not subsurface cultural remains still survive outside the investigated portions of these sites, but their site boundaries do extend beyond the right-of-way, and thus the potential for additional subsurface cultural resources cannot be discounted. Accordingly, the status of these cultural resources as eligible to the NRHP should be continued provisionally.

Testing only was carried out at 11 sites along the US 54 corridor. These sites contained a variety of prehistoric and historic resources. At nine of these sites (LA 110358, LA 115257, LA 115258, LA 115261, LA 115264, LA 126178, LA 128701, LA 128707, and LA 128710), no significant data potential was demonstrated and they were deemed not eligible to the NRHP. No further work or management measures were recommended for these sites. At the two other tested-only sites (LA 115255 and LA 128709), significant data potential was demonstrated, and they both were recommended eligible to the NRHP. Both of these sites contain rich prehistoric remains, including probable Archaic pithouses at LA 115255, and LA 128709 also contains substantial historic remains. At LA 115255, the NMSHTD re-designed the right-of-way to avoid this site, and so it remains protected. At LA 128709, planned construction activities included only a small corner of the site, and testing investigations revealed no significant cultural resources in this portion of the site. Significant cultural resources at this site remain outside the right-of-way.

As part of the management for the NRHP-eligible sites, it is recommended that fencing be maintained along the right-of-way and impact area margins of each site. Fencing will protect these sites from any inadvertent impacts during US 54 construction activities, and, for the data recovery sites, also will serve as clear boundary markers between the investigated and non-investigated portions of the sites.

In summary, testing and data recovery investigations along US 54 exhausted the data potential of all remains within impacted portions of the sites, and no cultural resources will be affected within the portions of these sites impacted by highway construction project. At all 13 sites deemed eligible for the inclusion in the NRHP, however, significant, or potentially significant, cultural resources remain in place beyond the boundaries of the US 54 project construction. Should any future, ground-disturbing activities, which would fall under appropriate regulations, be planned for these sites, such activities should be preceded by a testing and/or data recovery plan. Should testing demonstrate the presence of intact, subsurface archaeological resources, and construction activities are to proceed, data recovery should be carried out. Should testing fail to reveal the presence of additional, significant cultural resources at any of these sites, their status as eligible to the NRHP should be discontinued.



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